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Bethesda, Md. 20084

MANUAL FOR MONO-HULL OR TWIN-HULL SHIP MOTION PREDICTION COMPUTER PROGRAM

by

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and

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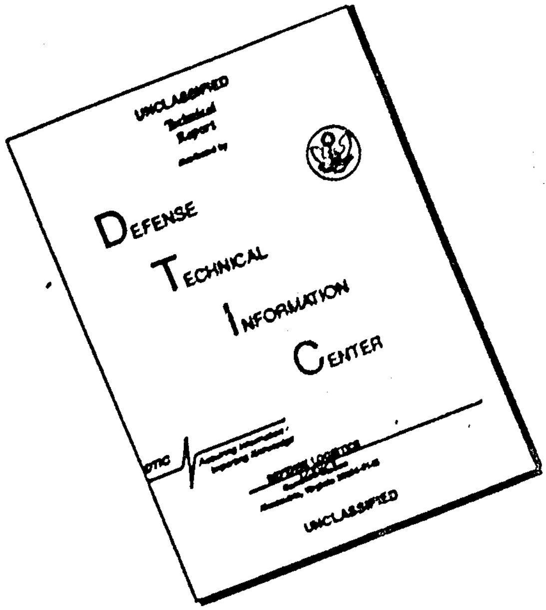

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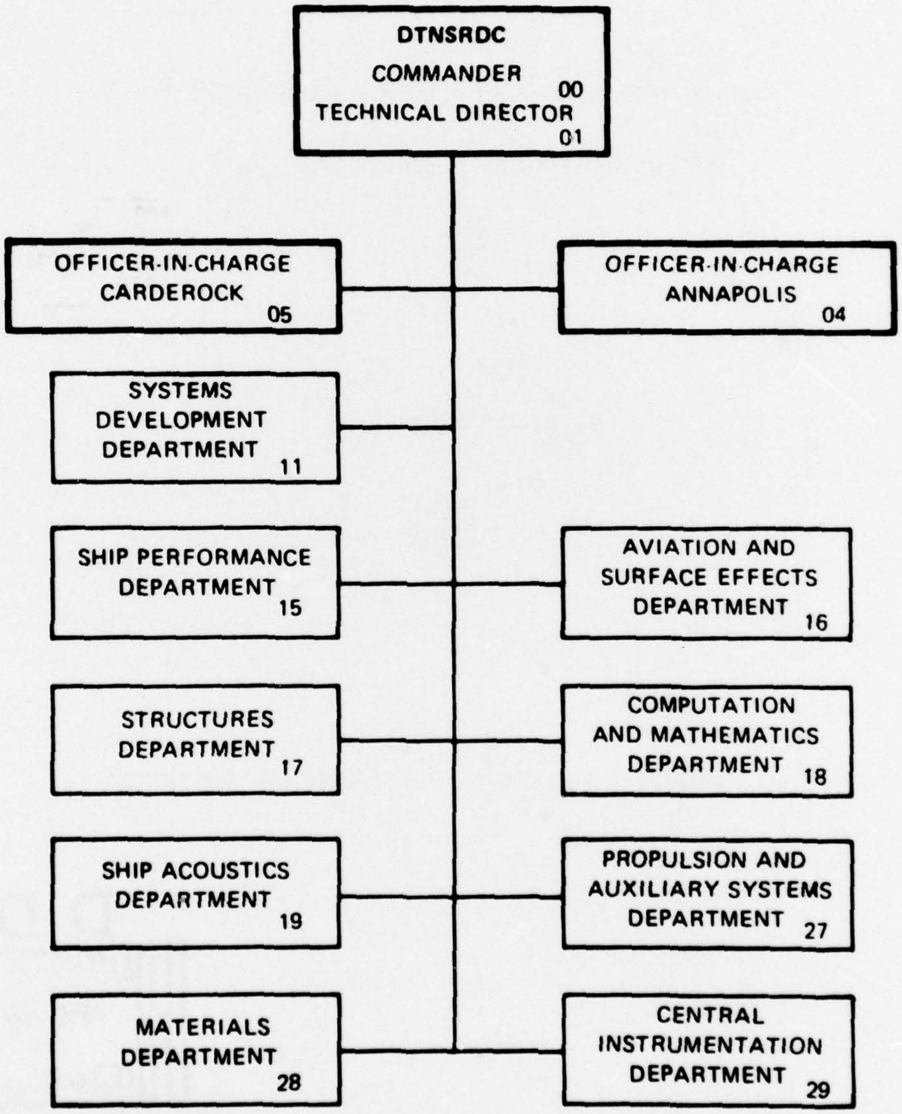

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Descriptions of two digital computer programs which calculate the motion of a mono-hull ship or a twin-hull ship are given. The ship is assumed to be advancing at constant speed with arbitrary heading in regular waves. The heave and pitch motion equations are solved in the program MOT35; the sway, roll and yaw motion equations are solved in the program MOT246. Computer input and output and program usage are described. Listings of the program as well as sample input and output are given.

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TABLE OF CONTENTS

	Page
ABSTRACT	1
ADMINISTRATIVE INFORMATION	1
INTRODUCTION	2
GENERAL BACKGROUND FOR PROGRAM USAGE	3
PROGRAM ORGANIZATION	6
INPUT	10
OUTPUT	14
APPENDIX A - PROGRAM LISTING OF MOT35	19
APPENDIX B - PROGRAM LISTING OF MOT246	87
APPENDIX C - DETERMINATION OF ENCOUNTER FREQUENCIES IN FOLLOWING WAVES	131
APPENDIX D - DATA INPUT DESCRIPTIONS	137
APPENDIX E - SAMPLE COMPUTER INPUT AND OUTPUT	145
APPENDIX F - PROGRAM FOR IRREGULAR SEA CALCULATIONS	211
ACKNOWLEDGMENTS	233
REFERENCES	234

LIST OF FIGURES

Page

FIGURE 1 - Flow Chart for MOT35 and MOT246 7

FIGURE 2 - Offset Data 13

LIST OF TABLES

Table 1 - Non-Dimensionalization Factors for Computer Output Variables 15

ABSTRACT

Descriptions of two digital computer programs which calculate the motion of a mono-hull ship or a twin-hull ship are given. The ship is assumed to be advancing at constant speed with arbitrary heading in regular waves. The heave and pitch motion equations are solved in the program MOT35; the sway, roll and yaw motion equations are solved in the program MOT246. Computer input and output and program usage are described. Listings of the programs as well as sample input and output are given.

ADMINISTRATIVE INFORMATION

This project was funded by the High Performance Vehicle Hydrodynamic Program of the Ship Performance Department, David W. Taylor Naval Ship Research and Development Center, under Work Unit 1507-200.

INTRODUCTION

This report describes the data input required for the implementation of the computer programs MOT35 and MOT246. The programs are written in FORTRAN IV for use on the CDC 6700 at the David W. Taylor Naval Ship Research and Development Center (DTNSRDC). These programs calculate the motions of a mono-hull ship or a twin-hull ship moving in a regular wave train of arbitrary heading. The ships can have stationary stabilizing fins at two arbitrary longitudinal locations. The amplitudes and phases of the motions are given as functions of encounter frequency.

The theoretical development for the solved equations is described in a separate report.(1)* These equations of motion are formulated in linear second-order differential equations. These are separated into three independent groups representing, respectively, the motion of surge, heave-pitch, and sway-roll-yaw. The hydrodynamic coefficients in the equations of motion are divided into three categories. The coefficients which can be obtained under the potential-flow assumption for a non-lifting body belong to the first category. These coefficients are obtained by strip theory based on the solution of the two-dimensional hydrodynamic problem of cylinders oscillating on the free surface. The wave exciting coefficients are obtained by the Haskind relation. The hydrodynamic coefficients associated with the viscous nature of the fluid belong to the second category. These are obtained by the cross-flow approach for slender bodies with moderate angle of attack. The hydrodynamic coefficients contributed by the control surfaces belong to the third category. These are obtained by slender body theory for low-aspect ratio wing-body combination. For mono-hull ships without horizontal stabilizing fins, only the hydrodynamic coefficients in the first category are used.

Motion calculations are given for five degrees of freedom. Computation of surge is not made in the programs. Since the heave and pitch motion equations are assumed to be independent of the sway, roll and yaw motion equations, the solution of the equations is implemented in two separate computer programs: MOT35 for heave and pitch, MOT246 for sway, roll and yaw.

* References are listed on page 235.

Both programs can be used for calculating the motions of either a mono-hull or a twin-hull ship. This choice is determined by the value given by the input variable MONO.

The degree of reliability of the mathematical model is checked by comparing the computations with experimental results for SWATH configurations in Reference 1. In general, the agreement between the two results are found to be as good as in the case of mono-hull ships.(2) For roll motion, the correlation for SWATH configurations appears to be better than that for mono-hull ships. The computation of roll in MOT246 does not include the bilge keel effects as does the mono-hull ship program(3) but the bilge keel effect may be represented by choosing proper values for the viscous lift coefficients (XZVL) and the cross-flow drag coefficient (XZFO).

For computations of motion in irregular seas, the transfer functions computed by MOT35 and MOT246 are used for input to another program called SMOTION which has been developed at the Center. The output of SMOTION provides the significant amplitudes of displacement, velocity and acceleration of the modes of motion desired as well as the absolute and relative vertical or lateral motion at any given point of the hull. It also provides the percentage of exceedance of a given motion for ships operating in the North Atlantic Ocean.

The data card input deck used for the two programs MOT35 and MOT246 is the same. A listing of data input, calculated geometric information and motions (transfer functions) as functions of non-dimensional encounter frequency are given in the computer output. If requested, added mass and damping coefficients and wave exciting forces and moments are also printed.

Program usage is described in this manual. Included are discussions of program structure, input, output and program implementation.

GENERAL BACKGROUND FOR PROGRAM USAGE

The two motion programs presented here have evolved from the Center's efforts in developing analytical prediction methods for mono-hull and twin-hull ships. The main theoretical basis is the source-distribution method for solving the boundary-value problem for oscillating two-dimensional cylinders. Once the method is developed for single cylinders (4), this can

be extended to twin cylinders[5]. With the slender body assumptions, these basic two-dimensional solutions can be integrated to obtain the hydrodynamic coefficients involved in the equations of motion. This approach is now widely accepted as a practical tool to compute ship motions induced by ocean waves.

The Center has developed a comprehensive computer program[3] to compute the motion of mono-hull ships in six degrees of freedom and various structural loadings induced by the ship motion and waves. The present program is developed to computer the motion of twin-hull ships following the same approach as used in the mono-hull motion program. However, one of the major deficiencies in the prior programs has been the underestimated damping coefficients in the heave, pitch and roll modes. The necessity of introducing viscous damping coefficients was almost imperative if any realistic prediction of motion was to be made. The degree of difficulty in obtaining reliable damping coefficients is well known to those who have attempted to predict the roll motion of mono-hull ships. The aforementioned difficulty was resolved by using an empirical approach borrowed from the method used for airships. Another difficulty was encountered with a twin-hull ship with stabilizing foils. Here, the hydrodynamic effects contributed by the foils should be properly accounted for in order to obtain a reliable prediction of motion. The foregoing additional hydrodynamic effects made the programs much more complex than the mono-hull program.

The required computer memory is reduced by dividing the solution of the equations of motion into two programs: one for heave-pitch motion and one for sway-roll-yaw. This also saves unnecessary computation when only certain modes of motion are of interest. Thus roll motion in beam waves, and heave and pitch in head waves can be calculated without solving all the equations. Results from both programs are sometimes needed. For example, when computing the absolute or relative vertical motion of a point on the hull in oblique waves, the heave, pitch and roll motions are required. For this and similar computations the results from the two programs can be stored on tape. Then these results can be used in a third program to make the desired computations.

In the development of these programs, the option of computing motions for a mono-hull ship has been included. The mono-hull ships can have asymmetric sections.* In the computations for mono-hull ships, the effects of stationary stabilizing fins can be included. The roll damping contributed by bilge keels is not included in the present programs. However, the bilge keel effect can be included if proper viscous damping coefficients, one depending on the forward speed and the other being independent of the speed, are given as input in the MOT246 program. Computations using this approach should be correlated with available experimental data in order to determine the proper values of the viscous damping coefficients for the bilge keel effects.

In the input data the wave heading angles, β, must be given values in the range from 0 through 180 degrees. Since the transfer functions for $\beta = -\alpha$ are the same as those for $\beta = +\alpha$, results for all headings can be calculated.

A part of the input data to the present program is a set of nondimensional encounter frequencies. These frequencies for given ship speeds can be used to compute the incoming wave lengths or frequencies. When the wave heading β, is in the quarter between the beam ($\beta = \pi/2$) and the stern, ($\beta = 0$) there can exist three different wave lengths for a given frequency of encounter, depending on the speed of the ship. Thus, when the motion results are to be obtained at reasonable intervals of the wave frequency so that the motions in irregular seas can be computed, an adjustment of the intervals of frequencies of encounter should be made for each given speed. In the present programs for the computation of motions for $0<\beta<\frac{\pi}{2}$, the ratios of wave length to ship length and the desired increment of the wave length to ship length ratio between the neighboring ratios are to be chosen as input data instead of the nondimensional frequencies of encounter which should be given if the waves are approaching the ship from the bow quarter $90<\beta<180$.

---

*In the computation for a conventional catamaran ship in head waves, the computed motion of its demihull (which is treated as a mono-hull) showed better agreement with the model experimental results than the twin-hull results did.[7]

PROGRAM ORGANIZATION

The programs presented in this report are organized with the use of overlays. These overlays consist of programs, subroutines and functions. The structure of MOT35 is very similar to that of MOT246. With the exception of the program PGM5, both MOT35 and MOT246 have programs with the same names which are used for the same purposes. The structure of these programs resembles that of the Frank Close-Fit Computer Program.[6] The close-fit technique utilized in computing the base hull two-dimensional added mass and damping coefficients has been revised to be applicable for both twin cylinders and a single cylinder. (The alternative Lewis form method for a single cylinder is not included in the present programs). In addition, the option of calculating motions in an irregular seaway by the Pierson-Moskowitz formula has been retained in MOT35. For a mono-hull ship travelling in head seas the heave and pitch motion calculations from MOT35 are equivalent to those obtained from the Frank program. However, there are many differences between the Frank program and the present programs. The program user should note that the form used for the input differs.

The program MOT35 and MOT246 are organized with the use of overlays. To facilitate program alteration and usage the DTNSRDC program EDIT* is used.

A general flow chart for both MOT35 and MOT246 is given in Figure 1. Listings of the programs are given in Appendices A and B. Brief descriptions of the overlay programs, subroutines and functions are given below.

Programs

MAIN is used to initiate program execution.

MOT35 (or MOT246) is used to read and write all the input data.

PGM1 is used to calculate geometric and hydrostatic quantities.

PGM1A is used to determine non-dimensional frequencies for calculations where the heading angle is $0<\beta<90$. See Appendix C for further discussion of the technique used.

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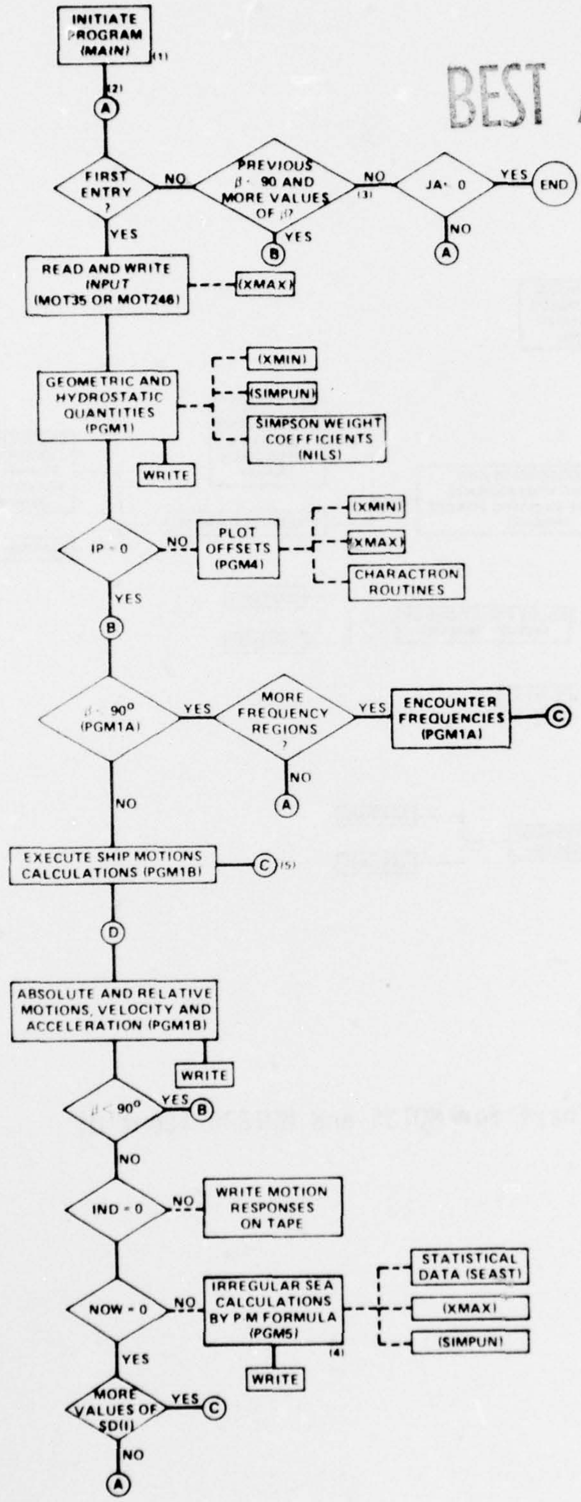
* The Edit Control Card Program was described in a technical note by M.E. Hass and P.E. Buttey of the Center's Computation and Applied Mathematics Department.



(1) PROGRAM NAMES ARE GIVEN IN PARENTHESES

(2) ENTRY POINTS ON THE FLOW CHART ARE INDICATED WITH SINGLE LETTERS

(3) β = WANG (I) = WAVE HEADING ANGLE

(4) NOT GIVEN IN MOT246

(5) SEE NEXT PAGE

Figure 1 - Flow Chart for MOT35 and MOT246

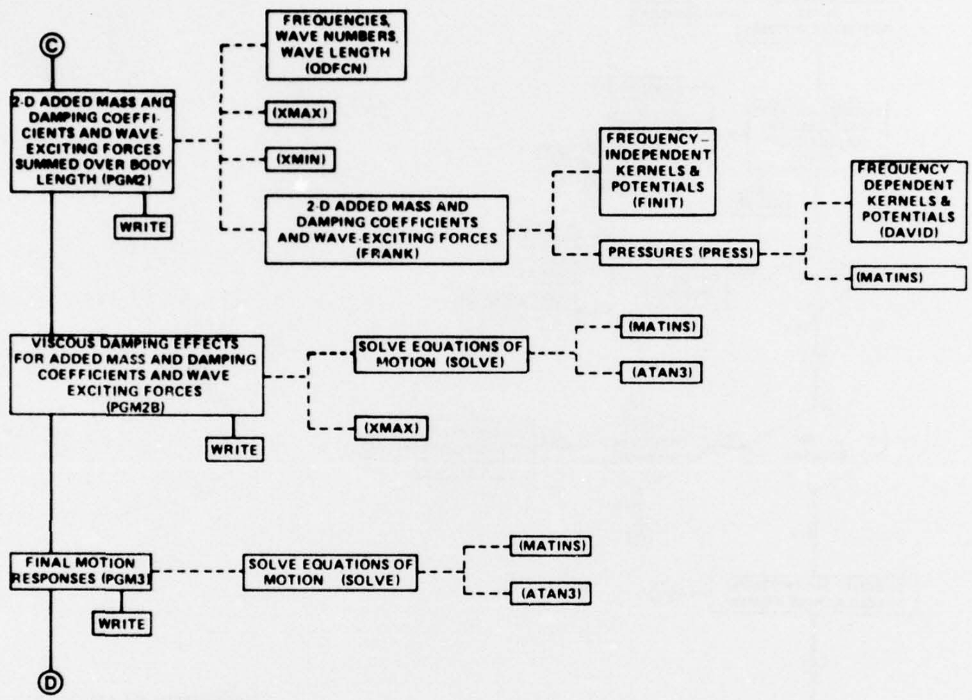


Figure 1 - Flow Chart for MOT35 and MOT246 (Cont'd)

PGM1B calculates absolute and relative motions, velocity and acceleration.

PGM2 is used to calculate added mass and damping coefficients.

PGM2B is used to calculate cross-flow viscous damping contributions to the damping coefficients and wave-exciting forces.

PGM3 is used to determine and to write the final motion responses (transfer functions).

PGM4 is used to plot the cross-sectional offsets.

PGM5 is used only in MOT35 to calculate the responses in irregular seas based on the Pierson-Moskowitz spectra formula.

Functions

ATAN3 is used to set the value of the arctangent of (0,0) to 0.

SIMPUN is used to evaluate an integral using the trapezoidal method.

XMAX is used to determine the maximum value in a given array.

XMIN is used to determine the minmum value in a given array.

Subroutines

DAVID is used to calculate the two-dimensional frequency-dependent velocity potential and its normal derivatives on the body due to a pulsating source of unit strength. (See Appendix A of Reference 4).

FINIT is used to calculate the logarithmic terms in the expression of a pulsating source of unit strength.

FRANK is used to calculate the added mass, damping and complex amplitudes of exciting forces and moments for a section.

MATINS is used for matrix inversion and for solution of linear equations by the pivot method.

NILS is used for evaluating Simpson's weight coefficients for an array of station numbers.

PRESS is used to calculate the pressures on the cross-section contours.

SEAST is used to calculate statistical sea state data for a given significant wave height.

SOLVE is used to solve the equations of motion.

QDFCN is used to calculate non-dimensional wave frequencies, wave numbers, and wave length to ship length for a given array of non-dimensional encounter frequencies.

INPUT

All data input for MOT35 and MOT246 are provided on digital computer cards. The same data deck form is utilized for both computer programs. Ship geometry and particular operating conditions must be specified. FORTRAN variable names, definitions and card formats for the input are listed in Appendix D. More detailed discussion of some input requirements and options are given below and in a section on output

GRAV

The input variable GRAV is used to indicate the length units used in the input. GRAV is the gravitational acceleration. If 9.807 is given then it is assumed in the program that all input with length dimensions are being given in meters; if 32.174 or 0. are given it is assumed that feet are the units used. All data must be given in the same units.

NOW

For irregular sea calculations in MOT35, NOW should be given a non-zero value. This option should be used only if all length units in the input are given in feet (that is, when GRAV = 0. or GRAV = 32.174).

WANG (I)

When any of the wave heading angles (denoted WANG (I)) is less than 90 degrees certain restrictions are placed on program input. (Note that WANG (I) = 180 degrees for head seas). In this case JA must be defined as 2, IND as 0. The values of WANG (I) must be given in ascending order.

OMEN (I)

The values for non-dimensional frequency are defined in the program differently, depending on the values of the wave heading angle. For all values of WANG (I) less than 90 degrees, motion calculations are made for non-dimensional encounter frequency values based on the input (using RWS(1,I,1) and RWS(2,I,1). For other values of WANG (I) the calculations are made for all values of OMEN (I) which are defined by $\omega\sqrt{L/g}$ where ω is the encounter frequency in radians per second, L is the ship length given by the input EL and g is the gravitational acceleration. The technique used for calculations for the heading angle less than 90 degrees is discussed in Appendix C.

NLOOP

For the heave, pitch and roll motions for twin-hulls and for the roll motion for mono-hulls, the effects of nonlinear viscous damping should be included in the computation. Although the computation is performed with the method of equivalent linearization of the nonlinear damping coefficients, it requires prior knowledge of the motion amplitudes. Hence, the computation is carried out iteratively, with the first amplitude of motion obtained without the nonlinear damping, until a reasonable convergence of the motion amplitude is obtained.

NLOOP is the maximum number of such iterations to be used in Program PGM2B. NLOOP may be defined as 0 if inclusion of the nonlinear damping is deemed unnecessary. The iteration continues until the value of the maximum roll motion (in MOT246) or the maximum heave motion (in MOT35) converges with an absolute error for the last two values of less than 10% or until the iteration has been repeated NLOOP times.

The iterative technique is not used if the heave amplitude divided by wave amplitude is less than 0.9 or the maximum roll amplitude divided by wave amplitude and multiplied by one-half of the centerline to centerline distance for twin-hulls or one-half beam for mono-hulls is less than 0.8. If these magnitudes are too small or the convergence criteria is not met within NLOOP iterations, appropriate diagnostic statements are printed and normal calculation continues. The program user should check for such diagnostics.

X(I,J), Y(I,J)

Several variables are used to describe the hull shape. Data should be given for about twenty stations which span the length of the ship at regular (not necessarily even) intervals, starting at the bow. The number of stations to be described is denoted by NOS. The station number to be associated with I^{th} set of offsets is denoted by ST(I). Note that the distance between the Station Numbers 0 and 20 is assumed to equal the value given by EL which can be any length within the overall length of the ship. All stations are spaced according to this scale. Values of

ST(I) can be negative or greater than 20, in which case the stations should be selected in pairs of even intervals. The value of ST(I) = 10.0 (i.e., the station located at the middle of EL) should always be included.

The variable MPS (I) indicates whether the I^{th} station described is part of a parallel body section. A value of 0 indicates that the station is not part of a parallel section; 1 and 2 indicate that the station is, respectively, the first or one of the subsequent stations (including the last one) in the parallel section. All offset data must be given for stations in a parallel section and stations must be distributed along the parallel section. However, for the stations having MPS(I) = 2, the sectional added mass and damping computations will not be repeated but will be replaced by the values obtained at the first station of the parallel body. If a ship has a substantial parallel middle body, the foregoing scheme would save considerably in the computational time and cost.

The variable NM(I) indicates the number of pairs of x and y coordinates that will be used to describe the I^{th} station. This value may be 0 for the bow or stern.

The x and y coordinates are defined using the arrays X(I,J) and Y(I,J), respectively. Each cross section is approximated by a polygon with corners defined by these x and y values. These coordinates should be evenly distributed since pressures are assumed to be constant over a linear segment between the neighboring points. A set of values of x for the I^{th} station are given first and then followed by a set of the corresponding values of y for that station. This is repeated for each station for which NM(I) is greater than 0. The origin of the x-y coordinate system is at the point of maximum draft of all stations at the longitudinal centerplane of one hull. Figure 2 indicates the coordinate system and the order data should be given in for each of the four types of hull configurations, with the appropriate value of MONO indicated. Also indicated are the coordinate points which must be included.

For the hydrodynamic computations, the origin of the coordinate system at each cross section is shifted to the midpoint of the overall beam of the cross section (of two hulls) at the calm waterline.

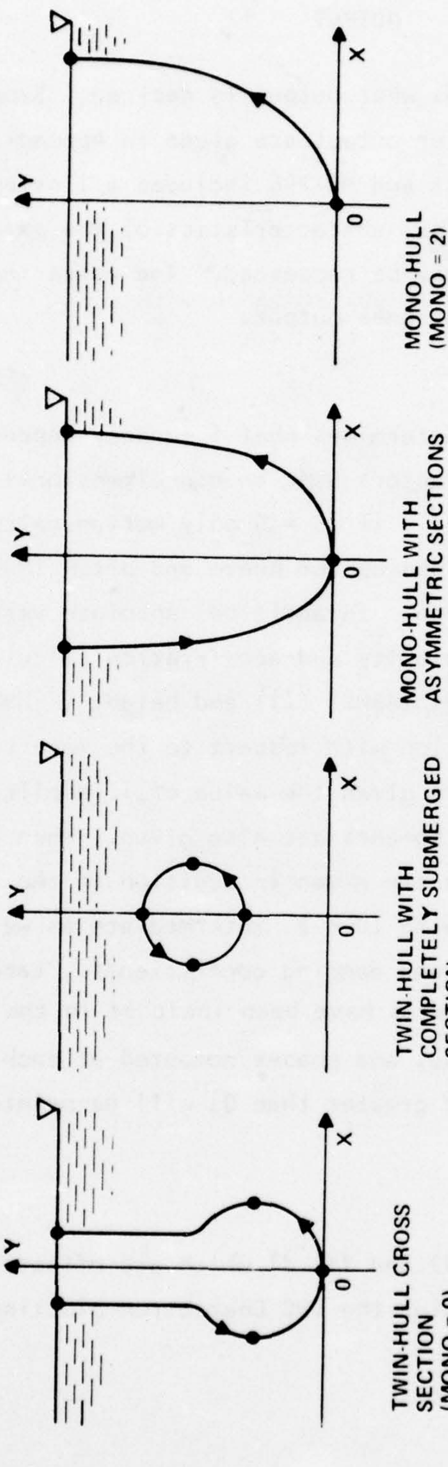


Figure 2 - Offset Data

OUTPUT

The program user specifies what output is desired. Sample input data and the resulting computer output are given in Appendix E. The printed output from both MOT35 and MOT246 includes a listing of the input data, a table of principal characteristics of the ship and motion results. Additional output may be requested. The three input variables IG, IP and IND control the optional output.

IG

The control variable IG determines what frequency-dependent hydrodynamic variables are printed. The factors used to non-dimensionalize these variables are given in Table 1. If IG = 0 only motion calculations are printed. The amplitudes and phases for heave and pitch (MOT35) and sway, roll and yaw (MOT246) are given. In addition, absolute vertical (MOT35) or lateral (MOT246) motion velocity and acceleration calculations are given at specified station locations (RBMST (I)) and height (RBMHT(I) for MOT246 only.) Relative vertical motion with respect to the wave surface is also calculated in MOT35. If IG is given the value of 1, amplitudes and phases for wave exciting forces and moments are also given. When IG is 2 the added mass and damping coefficients are given in addition to the information printed with IG = 1. Also, with IG = 2, intermediate as well as final results are given for the added mass and damping coefficients. Labels are used to indicate which contributing terms have been included in the results. In addition, the motion amplitudes and phases computed at each cycle of the iterative calculations (NLOOP greater than 0) will be printed if IG is defined as 3.

IP

The input variables X(I,J) and Y(I,J) which are offsets for cross-sections of the hull can be plotted using the CDC Charactron plotting routine if IP is defined as 1.

TABLE 1

NON-DIMENSIONALIZATION FACTORS FOR COMPUTER OUTPUT VARIABLES

VARIABLE	DIVIDING FACTORS
A_{22}	m
A_{24}	$m\ell$
A_{26}	$m\ell$
A_{33}	m
A_{35}	$m\ell$
A_{44}	$m\ell^2$
A_{46}	$m\ell^2$
A_{53}	$m\ell$
A_{55}	$m\ell^2$
A_{62}	$m\ell$
A_{64}	$m\ell^2$
A_{66}	$m\ell^2$
B_{22}	$m\sqrt{g/\ell}$
B_{24}	$m\sqrt{g\ell}$
B_{26}	$m\sqrt{g\ell}$
B_{33}	$m\sqrt{g/\ell}$
B_{35}	$m\sqrt{g\ell}$
B_{44}	$m\ell\sqrt{g\ell}$
B_{46}	$m\ell\sqrt{g\ell}$
B_{53}	$m\sqrt{g\ell}$

TABLE 1 (Cont'd)

NON-DIMENSIONALIZATION FACTORS FOR COMPUTER OUTPUT VARIABLES

VARIABLE	DIVIDING FACTORS
B_{55}	$m\ell\sqrt{g\ell}$
B_{66}	$m\ell\sqrt{g\ell}$
$F_2^{(e)}$	mgA
$F_3^{(e)}$	$\rho g A_w A$
$F_4^{(e)}$	mgA
$F_5^{(e)}$	$\rho g I_w A/\ell$
$F_6^{(e)}$	mgA
ξ_2	A
ξ_3	A
ξ_4	$\frac{2A}{B}$
ξ_5	$\frac{2A}{\ell}$
ξ_6	$\frac{2A}{\ell}$
ω	$\sqrt{g/\ell}$

where

A	wave amplitude
A_w	waterplane area
A_{ij}	added mass coeffficient
B_{ij}	damping coefficient
B	beam for monohulland separation distance between the centerplanes of twin-hull

$F_i^{(e)}$	wave exciting force or moment in the ith mode
g	acceleration due to gravity
I_w	waterplane area moment of inertia about the y-axis
ℓ	ship length given by EL
m	displaced mass of ship
ξ_i	motion displacement in the ith mode
ω	encounter frequency

IND

The values of the motion amplitudes and phases can be transfered to a tape if IND is defined as 1. When JA is defined as 1, this option will facilitate use of a modified version of the program SMOTION which is used for seakeeping calculations in irregular seas using Pierson-Moskowitz and Station INDIA sea spectra. SMOTION is briefly discussed and listed in Appendix F.

APPENDIX A

PROGRAM LISTING OF MOT35

```
      OVERLAY(OVFILE,0,0)
      PROGRAM MAIN(INPUT=512,OUTPUT=512,TAPE22=512,TAPE48=512,
     X   TAPE5=INPUT,TAPE6=OUTPUT)
C
      COMMON/HP1/  NPAG,TITLE(8),PATT(7),RATIO
      COMMON/HP2/  ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/HP3/  NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X             AVBM(30),ST(30),IN(30),SQAR(30),X(30,20),Y(30,20)
      COMMON/HP4/  NOT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/HP5/  VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/HP6/  NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/HP7/  NFN,NFNS,FN(6),FNS(6)
      COMMON/HP8/  NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/HP9/  NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/HP10/ XZFO,XZVL,XZHB,XZPB,KV,KW
      COMMON/HP11/ CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/HP12/ CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/HP13/ GRAV,DEPCAT,SD(6),RBMST(10)
      COMMON/HP14/ EL,GCB,GYR,RGY,VCG,BRCL,RF33,RP35,RM55
      COMMON/HP15/ A33(30),A35(4,30),A53(4,30),A55(4,30),C35S,C55S,
     X             B33(4,30,3),B35(4,30,3),B53(4,30,3),B55(4,30,3)
      COMMON/HP16/ AHP(30),DHP(4,30),AP(30),DP(4,30)
      COMMON/HP17/ OMEGA,UN,PAH(19),PVH(19)
      COMMON/HP18/ BLOG(19,19),YLOG(19,19)
      COMMON/HP19/ KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/HP20/ II,EFH(4,30,3),EMP(4,30,3),EMK(4,30,3)
      COMPLEX II,EFH,EMP
C
C    END OF COMMON DECK
C       (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
      DATA PATT/6HMOT35 ,6H   HEA,6HVE AND,6H PITCH,6H MOTIO,6HNS OF ,
     X  6HPAGE  /
      DATA ISTART/0/
      NBTAS=0
      JC=0
      GO TO 1001
      CALL FLAGSV
      CALL PLOTDD
 1001 CONTINUE
      CALL AETSKC(5LMOT35)
       END
```

```
      OVERLAY(1,0)
      PROGRAM MOT35
C
C     HPM - CATAMARAN VERSION OF YF17 FOR ARBITRARY HEADING
C     OFFSETS MUST BE READ IN. THE X AXIS IS THE TRANVERSE BASE LINE OF
C     STATION 10. THE Y AXIS IS THE VERTICAL CENTER LINE OF STATION 10.
C     Y IS POSITIVE UP AND X IS POSITIVE TO THE RIGHT.
C     LOOKING FORWARD ON THE STARBOARD HULL AND STARTING AT THE BOW THE
C     OFFSETS ARE READ IN COUNTER-CLOCK WISE A STATION AT A TIME.
C     HULL SEPARATION DISTANCE MUST ALSO BE GIVEN. IT IS IDENTIFIED AS
C     SD(NSD) WHERE NSD IS THE NUMBER OF HULL SEPARATIONS TO BE RUN.
C     THE HULL SEPARATION IS THE DISTANCE FROM THE CENTER LINE OF THE
C     CATAMARAN TO THE CENTER LINE OF STATION 10.
C
      COMMON/HP1/  NPAG,TITLE(8),PATT(7),RATIO
      COMMON/HP2/  ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/HP3/  NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X             AVBM(30),ST(30),IN(30),SQAR(30),X(30,20),Y(30,20)
      COMMON/HP4/  NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/HP5/  VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/HP6/  NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/HP7/  NFN,NFNS,FN(6),FNS(6)
      COMMON/HP8/  NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/HP9/  NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/HP10/ XZFO,XZVL,XZHB,XZPB,KV,KW
      COMMON/HP11/ CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/HP12/ CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/HP13/ GRAV,DEPCAT,SD(6),RBMST(10)
      COMMON/HP14/ EL,GCB,GYR,RGY,VCG,BRCL,RF33,RP35,RM55
      COMMON/HP15/ A33(30),A35(4,30),A53(4,30),A55(4,30),C35S,C55S,
     X             B33(4,30,3),B35(4,30,3),B53(4,30,3),B55(4,30,3)
      COMMON/HP16/ AHP(30),DHP(4,30),AP(30),DP(4,30)
      COMMON/HP17/ OMEGA,UN,PAH(19),PVH(19)
      COMMON/HP18/ BLOG(19,19),YLOG(19,19)
      COMMON/HP19/ KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/HP20/ II,EFH(4,30,3),EMP(4,30,3),EMK(4,30,3)
      COMPLEX II,EFH,EMP
C
C    END OF COMMON DECK
C      (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
      DIMENSION YJK(20),YBG(30)
    1 FORMAT(8A6)
    2 FORMAT(12I5)
    3 FORMAT(8F10.5)
    4 FORMAT(4F9.4,2I9)
    5 FORMAT(1H1,14A6,18X,A6,I4/)
    6 FORMAT(1H0,5X,54HSTATION 10.0 NOT GIVEN - READ INPUT DATA FOR NEXT
     1 SHIP)
```

```
    7 FORMAT(4F10.5,2I5)
8     FORMAT(1H0,5X,23HCOMPUTED FROUDE NUMBERS)
    9 FORMAT(/* DATA INPUT CARDS*/ 10X,*1*,9X,*2*,9X,*3*,9X,*4*,9X,
     X  *5*,9X,*6*,9X,*7*,9X,*8*/1X,8(*1234567890*))
   40 FORMAT(8F9.4)
   51 FORMAT(1X,8A6)
   52 FORMAT(1X,12I5)
   53 FORMAT(1X,8F10.5)
   54 FORMAT(1X,4F9.4,2I9)
   57 FORMAT(1X,4F10.5,2I5)
  200 FORMAT(1H0,I1)
 3000 FORMAT(12H1 END OF JOB)
  335 FORMAT(30X,9HSTATION  ,F9.4)
   78 NPAG=0
      IF(JC.EQ.2 .AND. NBTAS.GT.0) CALL AETSKC(5LPGM1A)
       ID = 1
      READ(5,1) (TITLE(I),I=1,8)
      READ(5,2) MONO,JA
      IF(JA.LE.0) GO TO 77
      READ(5,3) SCALE,GRAV
      READ(5,2) NFR,NBTA,NFN,NSD,NSTR,NOS,NLOOP,IG,LP,IND
      READ(5,3) (OMEN(I),I=1,NFR)
      READ(5,3) (WANG(I),I=1,NBTA)
      READ(5,3) (FN(I),I=1,NFN)
      READ(5,3) (SD(I),I=1,NSD)
      READ(5,3) (RBMST(I),I=1,NSTR)
      READ(5,3) HTDUM
      OMIN=OMEN(1)
      NBTAT=NBTA
      NBTAS=0
      WANG(NBTAT+1)=777.
      NBTAQ=0
      DO 17 I=1,NBTA
      IF(WANG(I).LT.90.) NBTAQ=NBTAQ+1
   17 CONTINUE
      NFRS=NFR
      DO 18 I=1,NFR
   18 OMENS(I)=OMEN(I)
      JC=1
      IF(NBTAQ.NE.0) JC=2
      JB=1
      DO 19 I=1,NFN
   19 FNS(I)=FN(I)
      NFNS=NFN
      KASE(1)=0
      NPAG=NPAG+1
      WRITE(6,5)  (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,9)
      WRITE(6,51)  (TITLE(I),I=1,8)
      WRITE(6,52)  MONO,JA
      WRITE(6,53)  SCALE,GRAV
      WRITE(6,52)  NFR,NBTA,NFN,NSD,NSTR,NOS,NLOOP,IG,LP,IND
      WRITE(6,53)  (OMEN(I),I=1,NFR)
      WRITE(6,53)  (WANG(I),I=1,NBTA)
```

```
      WRITE(6,53) (FN(I),I=1,NFN)
      WRITE(6,53) (SD(I),I=1,NSD)
      WRITE(6,53) (RBMST(I),I=1,NSTR)
      WRITE(6,53) HTDUM
      IF(SCALE.LE.0.) SCALE=1.
      IF(GRAV.LE.0.) GRAV=32.174
      IF(NSD.GE.1) GO TO 79
      NSD=1
      SD(1)=0.
   79 IF(JC.NE.2) GO TO 43
      IF(JA.NE.2) GO TO 43
      IF(NFN.GE.1) GO TO 144
      JB=1
      FN(1)=0.0
      GO TO 43
  144 CONTINUE
C
C     FOLLOWING OR QUARTERING SEA CASE
C
C    READ IN BOUNDS FOR RWS AND DELTA RWS
C       (RWS IS REAL WAVE LENGTH / LENGTH OF SHIP)
C
C     STORE BOUNDS IN    RWS(1,N,1)   N=1,NB
C           INCREMENTS  RWS(2,N,1)   N=1,NB-1
C           NUMBER OF BOUNDS IN RWS(3,1,1)
C
C     BOUNDS MUST BE IN ASCENDING ORDER FROM MINIMUM TO MAXIMUM
C
      READ(5,3) (RWS(1,N,1),N=1,8)
      READ(5,3) (RWS(2,N,1),N=1,8)
      READ(5,3) OMIN,OMAX,DOME
C
      NB=0
      DO 301 I=1,8
      IF(RWS(1,I,1).LE.0.0 ) GO TO 302
      NB=NB+1
  301 CONTINUE
  302 CONTINUE
      RWS(3,1,1)=NB
C
      WRITE(6,3) (RWS(1,N,1),N=1,NB)
      NB=NB-1
      WRITE(6,3) (RWS(2,N,1),N=1,NB)
      WRITE(6,3) OMIN,OMAX,DOME
C
   43 READ(5,3) EL,GYR,GYRT,GCB,VCG,GMT,DEPCAT,BRCL
      READ(5,3) FAL,FAY,DEPA,CHRDA,SPNA,THKA,CLFA,XZFA
      READ(5,3) FBL,FBY,DEPB,CHRDB,SPNB,THKB,CLFB,XZFB
      READ(5,7) XZFO,XZVL,XZHB,XZPB,KV,KW
      READ(5,4) (ST(I),BEAM(I),DRFT(I),AREA(I),NM(I),MPS(I),I=1,NOS)
      WRITE(6,53) EL,GYR,GYRT,GCB,VCG,GMT,DEPCAT,BRCL
      WRITE(6,53) FAL,FAY,DEPA,CHRDA,SPNA,THKA,CLFA,XZFA
      WRITE(6,53) FBL,FBY,DEPB,CHRDB,SPNB,THKB,CLFB,XZFB
      WRITE(6,57) XZFO,XZVL,XZHB,XZPB,KV,KW
      WRITE(6,54) (ST(I),BEAM(I),DRFT(I),AREA(I),NM(I),MPS(I),I=1,NOS)
```

```
      RGY=GYR
      MS=0
      DO 30 I=1,NOS
      IF(ST(I).NE.10.) GO TO 30
      MS=I
      GO TO 31
   30 CONTINUE
      MS=0
   31 NIX=NM(1)
      DO 10 I=2,NOS
      IF(NIX.GE.NM(I)) GO TO 10
      NIX=NM(I)
   10 CONTINUE
      IN(1)=IABS(NM(1))
      NUX=IN(1)
      DO 20 I=2,NOS
      IN(I)=IABS(NM(I))
      IF(NUX.GE.IN(I)) GO TO 20
      NUX=IN(I)
   20 CONTINUE
      DO 21 I=1,NOS
      BEAM(I)=BEAM(I)*SCALE
   21 DRFT(I)=DRFT(I)*SCALE
      IF(NUX.LE.0) GO TO 13
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      KIM=0
      DO 11 I=1,NOS
      YBG(I)=0.
      IF(IN(I).LE.0) GO TO 11
      LEE=3
      NUT=IN(I)
      IF(NUT.LE.8) GO TO 14
      LEE=5
   14 KIM=KIM+LEE
      IF(KIM.LE.50) GO TO 15
      KIM=LEE
      NPAG=NPAG+1
      WRITE(6,5) (PATT(J),J=1,6),(TITLE(J),J=1,8),PATT(7),NPAG
   15 WRITE(6,335) ST(I)
      READ(5,40) (X(I,J),J=1,NUT)
      READ(5,40) (Y(I,J),J=1,NUT)
      WRITE(6,40) (X(I,J),J=1,NUT)
      WRITE(6,40) (Y(I,J),J=1,NUT)
      DO 165 J=1,NUT
      X(I,J)=X(I,J)*SCALE
      Y(I,J)=Y(I,J)*SCALE
  165 YJK(J)=Y(I,J)
      YLGS=XMAX(NUT,YJK)
      YSML=XMIN(NUT,YJK)
      DRFT(I)=YLGS-YSML
      YBG(I)=YLGS
   11 CONTINUE
```

```
 13 IF(SCALE.EQ.1.) GO TO 23
    EL=EL*SCALE
    VCG=VCG*SCALE
    GMT=GMT*SCALE
    DEPCAT=DEPCAT*SCALE
    BRCL=BRCL*SCALE
    DO 22 I=1,NSD
 22 SD(I)=SD(I)*SCALE
 23 READ(5,2) NOW,NOL,NSP,NST
    IF(NOW.LE.0) GO TO 75
    READ(5,3) (WINK(I),I=1,NOW)
    READ(5,3) (SHLT(I),I=1,NOL)
    READ(5,3) (SPEED(I),I=1,NSP)
    READ(5,3) (STAT(I),I=1,NST)
    WRITE(6,3) (WINK(I),I=1,NOW)
    WRITE(6,3) (SHLT(I),I=1,NOL)
    WRITE(6,3) (SPEED(I),I=1,NSP)
    WRITE(6,3) (STAT(I),I=1,NST)
    NFN=NOL*NSP
    IF(NFN.GT.4 .OR. JB.EQ.3 .OR. JA.NE.1) GO TO 77
    OWAX=OMAX
    WRITE(6,8)
    JJ=0
    FACT=1.688
    IF(GRAV.LT.32.) FACT=.3048*FACT
    DO 150 L=1,NOL
    DO 150 M=1,NSP
    JJ=JJ+1
150 FN(JJ)=FACT*SPEED(M)/SQRT(GRAV*SHLT(L))
    WRITE(6,3) (FN(JJ),JJ=1,NFN)
 75 IF(MS.NE.0) GO TO 69
    WRITE(6,6)
    GO TO 78
69  DUM=XMAX(NOS,YBG)
    DO 16 I=1,NOS
    NUT=IN(I)
    IF(NUT.LE.0) GO TO 16
    DO 12 J=1,NUT
 12 Y(I,J)=Y(I,J)-DUM
 16  CONTINUE
    CALL AETSKC(4LPGM1)
 77 IF(LP.LE.0 .AND. IP.LE.0) GO TO 80
     ENDFILE 48
     ENDFILE 48
     REWIND 48
 80 IF(IND.EQ.0) GO TO 777
    I=777
    WRITE(22) I,I,I
    ENDFILE 22
    REWIND 22
777 WRITE(6,3000)
    END
```

```
      FUNCTION XMIN(N,X)
      DIMENSION X(30)
      XMIN=X(1)
      IF(N.LE.1) GO TO 4
      DO 2 K=2,N
      IF(XMIN.LT.X(K)) GO TO 2
      XMIN=X(K)
2     CONTINUE
4     RETURN
      END
```

```
      FUNCTION XMAX(N,X)
      DIMENSION X(30)
    1 XMAX=X(1)
      IF(N.LE.1) GO TO 4
      DO 2 K=2,N
      IF(XMAX-X(K))3,2,2
    3 XMAX=X(K)
    2 CONTINUE
    4 RETURN
      END
```

```
      FUNCTION SIMPUN(X,Y,N)
      DIMENSION X(50), Y(50)
      S=0.
      NN=N-1
      DO 1 J=1,NN
    1 S =S+(X(J+1) -X(J))*(Y(J)+Y(J+1))*0.5
      SIMPUN=S
      RETURN
      END
```

```
      OVERLAY(2,0)
      PROGRAM PGM1
C
      COMMON/HP1/  NPAG,TITLE(8),PATT(7),RATIO
      COMMON/HP2/  ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/HP3/  NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X             AVBM(30),ST(30),IN(30),SQAR(30),X(30,20),Y(30,20)
      COMMON/HP4/  NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/HP5/  VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/HP6/  NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/HP7/  NFN,NFNS,FN(6),FNS(6)
      COMMON/HP8/  NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/HP9/  NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/HP10/ XZFO,XZVL,XZHB,XZPB,KV,KW
      COMMON/HP11/ CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/HP12/ CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/HP13/ GRAV,DEPCAT,SD(6),RBMST(10)
      COMMON/HP14/ EL,GCB,GYR,RGY,VCG,BRCL,RF33,RP35,RM55
      COMMON/HP15/ A33(30),A35(4,30),A53(4,30),A55(4,30),C35S,C55S,
     X             B33(4,30,3),B35(4,30,3),B53(4,30,3),B55(4,30,3)
      COMMON/HP16/ AHP(30),DHP(4,30),AP(30),DP(4,30)
      COMMON/HP17/ OMEGA,UN,PAH(19),PVH(19)
      COMMON/HP18/ BLOG(19,19),YLOG(19,19)
      COMMON/HP19/ KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/HP20/ II,EFH(4,30,3),EMP(4,30,3),EMK(4,30,3)
      COMPLEX II,EFH,EMP
C
C    END OF COMMON DECK
C       (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
      DIMENSION SAS(30),SHB(30),HSB(30),XI(20),YI(20)
      DIMENSION FJ(30),VCBS(30)
    1 FORMAT(1H0,7X,*LENGTH BETWEEN PERPENDICULARS = *,F10.5,1X,A6)
    2 FORMAT(22X,*BEAM AT MIDSHIP = *,F10.5,1X,A6)
    3 FORMAT(21X,*DRAFT AT MIDSHIP = *,F10.5,1X,A6)
    4 FORMAT(25X,15HDISPLACEMENT = F10.3,10H LONG TONS)
    5 FORMAT(1H1,14A6,18X,A6,I4/)
    6 FORMAT(20X,20HBLOCK COEFFICIENT = F10.5)
    7 FORMAT(6X,*LONGITUDINAL CENTER OF BUOYANCY = *,F10.5,1X,A6,1X,
     X  *AFT OF F.P.*)
    8 FORMAT(6X,34HLONGITUDINAL CENTER OF BUOYANCY = F10.5,9H STATIONS)
    9 FORMAT(5X,*LONGITUDINAL CENTER OF FLOTATION = *,F10.5,1X,A6,
     X  * AFT OF F.P.*)
   10 FORMAT(5X,35HLONGITUDINAL CENTER OF FLOTATION = F10.5,9H STATIONS)
   11 FORMAT(10X,*VERTICAL CENTER OF BUOYANCY = *,F10.5,1X,A6,
     X  * FROM THE DESIGNED LOAD WATERLINE*)
   11 FORMAT(12X,28HRADIUS OF GYRATION/L.B.P. = F10.5)
   12 FORMAT(44H0 STATION      BEAM     DRAFT AREA COEFFICIENT)
   13 FORMAT(4F9.4)
```

```
 14 FORMAT(6X,10HSTATION = F9.4,6X,30HAREA COEFFICIENT CHANGED FROM F1
   10.4,2X,2HTO,2X,F10.4)
 15 FORMAT(1H0)
 69 FORMAT(13X,27HGIVEN CENTER OF BUOYANCY = F10.5,9H STATIONS)
 90 FORMAT(3F9.4,E15.8)
 92 FORMAT(1H0,5X,30HMINIMUM CRITICAL ENC. FREQ. = F8.4,16H DUE TO STA
   1TION F7.4)
206 FORMAT(1H0,30X,23H***DATA FOR ONE HULL***)
300  FORMAT(27X,13HBEAM/DRAFT = F10.5)
301  FORMAT(26X,14HLENGTH/BEAM = F10.5)
 66 FORMAT(1H0,5X,41HTHE HEAVE-HEAVE RESTORING COEFFICIENT IS F10.5/6X
   1,41HTHE HEAVE-PITCH RESTORING COEFFICIENT IS F10.5/6X,41HTHE PITCH
   2-PITCH RESTORING COEFFICIENT IS F10.5)
193  FORMAT(6X,32HCRITICAL ENC. FREQ. FOR STATION ,F7.4,3H = F8.4)
     UNITS=6HFEET
     IF(GRAV.LT.32.) UNITS=6HMETERS
     FST=EL/20.
     DO 16 K=1,NOS
     IF(IN(K).GT.0) GO TO 17
     SQAR(K)=AREA(K)*BEAM(K)*DRFT(K)
     VCBS(K)=0.
     GO TO 20
 17 NUT=IN(K)
     VCBS(K)=0.
     VCBA=0.
     VCBB=0.
     DO 18 J=1,NUT
     YI(J)=Y(K,J)
 18 XI(J)=X(K,J) + SD(I)
     YSML=XMIN(NUT,YI)
     DO 190 IJI=1,NUT
     NNN=IJI
     IF(YSML.EQ.YI(IJI)) GO TO 191
190 CONTINUE
191 IJI=NNN
     IF(MONO .GT. 1) GO TO 199
     IJ=IJI-1
     DO 122 J=1,IJ
122 VCBA=VCBA+ABS((X(K,J)+X(K,J+1))*(Y(K,J)**2-Y(K,J+1)**2))*0.25
     SQER=SIMPON(YI,XI,IJI)
     SQER=ABS(SQER)
     DO 195 JJJ=IJI,NUT
     IF(JJJ.EQ.NUT) GO TO 127
     VCBB=VCBB+ABS((X(K,JJJ)+X(K,JJJ+1))*(Y(K,JJJ)**2-Y(K,JJJ+1)**2))*
    *0.25
127 CONTINUE
     KKK=JJJ-IJI+1
     XI(KKK)=XI(JJJ)
195 YI(KKK)=YI(JJJ)
     SQER2=SIMPON(YI,XI,KKK)
     IF(MONO-1)56,57,199
 56 SQAR(K)=ABS(SQER2)-SQER
     VCBS(K)=VCBS(K)+VCBB+VCBA
     GO TO 55
```

```
 57 SQAR(K)=SQER + SQER2
    IF(X(K,1) .LE. 0. .AND. X(K,NUT) .LE. 0.) GO TO 59
    VCBS(K)=VCBS(K)+VCBB+VCBA
    GO TO 55
 59 VCBS(K)=VCBS(K)+VCBA-VCBB
    GO TO 55
199 SQER=SIMPUN(YI,XI,NUT)
    SQAR(K)=2.*ABS(SQER)
    NAT=NUT-1
    DO 125 J=1,NAT
125 VCBS(K) =VCBS(K)+0.25*ABS((X(K,J)+X(K,J+1))*(Y(K,J)**2-Y(K,J+1)**
   12))
    VCBS(K)=2.*VCBS(K)
 55 DO 196 J=1,NUT
    YI(J)=Y(K,J)
196 XI(J)=X(K,J)
    BEAM(K)=ABS(XI(NUT)-XI(1))
    IF(MONO.GT.1) BEAM(K) = 2.*BEAM(K)
    IF(BEAM(K).NE.0.0) GO TO 600
    AREA(K)=SQAR(K)/DRFT(K)**2
    X(K,1)=X(K,1)-0.001
    XI(1)=X(K,1)
     GO TO 20
600 AREA(K)=SQAR(K)/(BEAM(K)*DRFT(K))
 20 SS(K)=FST*ST(K)
 16 SAS(K)=SS(K)*SQAR(K)
    KPK=0
    LSD=0
    IF(NIX.GT.0) GO TO 21
    DO 32 K=1,NOS
    IF(NM(K).GT.0) GO TO 32
    IF((BEAM(K).LE.0.).OR.(DRFT(K).LE.0.)) GO TO 32
    AIR=AREA(K)
    RAT=0.5*BEAM(K)/DRFT(K)
    TAR=1.0/RAT
    IF(RAT.LE.1.0) GO TO 33
    BL=0.29456*(2.0-TAR)
    GO TO 34
 33 BL=0.29456*(2.0-RAT)
 34 UL=0.098125*(RAT+TAR+10.0)
    IF(AREA(K).GT.BL) GO TO 35
    AREA(K)=BL+0.0001
    GO TO 36
 35 IF(AREA(K).LT.UL) GO TO 32
    AREA(K)=UL-0.0001
 36 IF(KPK.GT.0) GO TO 37
    KPK=KPK+1
    NPAG=NPAG+1
    WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
    WRITE(6,15)
 37 WRITE(6,14)ST(K),AIR,AREA(K)
    LSD=LSD+1
    SQAR(K)=AREA(K)*BEAM(K)*DRFT(K)
    SAS(K)=SS(K)*SQAR(K)
 32 CONTINUE
```

```
   21 IF(NUX.LE.0) GO TO 25
      IF(KPK.GT.0) GO TO 93
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
   93 WRITE(6,12)
      DO 22 K=1,NOS
      IF(IN(K).LE.0) GO TO 22
      LSD=LSD+1
      IF(AREA(K).LT.1000.0) GO TO 91
      WRITE(6,90)ST(K),BEAM(K),DRFT(K),AREA(K)
      GO TO 22
   91 WRITE(6,13)ST(K),BEAM(K),DRFT(K),AREA(K)
   22 CONTINUE
      IF(NIX.LE.0) GO TO 25
      OX=100.0
      IF(LSD.LT.23) GO TO 201
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
201   WRITE(6,15)
      DO 23 K=1,NOS
      IF(NM(K).LE.0) GO TO 23
       IF (BEAM(K) .NE. 0.0) GO TO 601
       FJ(K) = 0.0
       GO TO 602
  601  CONTINUE
      A=3.1415927*DRFT(K)/BEAM(K)
      A=A/TANH(A)
      FJ(K)=SQRT(A*EL/DRFT(K))
  602  CONTINUE
      IF(FJ(K).GT.OX) GO TO 233
      OX=FJ(K)
      JOHN=K
  233 WRITE(6,193)ST(K),FJ(K)
   23 CONTINUE
      WRITE(6,92)OX,ST(JOHN)
   25 CONTINUE
   30 VOL=SIMPUN(SS,SQAR,NOS)
       IF(BEAM(MS).EQ.0.0) GO TO 703
      BLOCK=VOL/(EL*BEAM(MS)*DRFT(MS))
       GO TO 704
 703  BLOCK=0.0
 704  CONTINUE
      VCB=SIMPUN(SS,VCBS,NOS)/VOL
      BOY=SIMPUN(SS,SAS,NOS)/VOL
      GYR=RGY**2
      CBL=BOY/FST
      IF(GCB.LE.0.0) GO TO 68
      BOY=FST*GCB
   68 DO 19 K=1,NOS
      SHB(K)=(SS(K)-BOY)*BEAM(K)
   19 HSB(K)=(SS(K)-BOY)*SHB(K)
      AMP1=SIMPUN(SS,BEAM,NOS)/EL**2
      AMP2=SIMPUN(SS,HSB,NOS)/EL**4
```

```
      RF33=EL**3*AMP1/VOL
      RM55=EL**3*AMP2/VOL - ABS(VCB+VCG)/EL
      RP35=SIMPUN(SS,SHB,NOS)/VOL
      CFL=BOY+EL*RP35/RF33
      FLC=CFL/FST
      PST=FST*CBL
      FACT=35.89744
      IF(GRAV.LT.32.) FACT=.02832*FACT
      VOL=VOL/FACT
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,206)
      WRITE(6,1) EL,UNITS
      WRITE(6,2) BEAM(MS),UNITS
      WRITE(6,3) DRFT(MS),UNITS
      WRITE(6,4)VOL
      VOL=VOL*FACT/EL**3
      WRITE(6,6)BLOCK
      WRITE(6,7) PST,UNITS
      WRITE(6,8)CBL
      IF(GCB.LE.0.0) GO TO 67
      WRITE(6,69)GCB
      PST=FST*GCB
   67 WRITE(6,9) CFL,UNITS
      WRITE(6,10)FLC
      WRITE(6,111) VCB,UNITS
      WRITE(6,11)RGY
      BDR=BEAM(MS)/DRFT(MS)
      WRITE(6,300)BDR
      IF(BEAM(MS).EQ.0.0) GO TO 700
      ELBR=EL/BEAM(MS)
      GO TO 701
  700 ELBR=0.0
  701 CONTINUE
      WRITE(6,301)ELBR
      WRITE(6,66) RF33,RP35,RM55
      DO 31 K=1,NOS
      SS(K)=SS(K)/EL
      SQAR(K)=SQAR(K)/EL**2
      BEAM(K)=BEAM(K)/EL
      DRFT(K)=DRFT(K)/EL
      IF(NM(K).LE.0) GO TO 31
      NUT=IN(K)
      DO 24 J=1,NUT
      X(K,J)=X(K,J)/EL
   24 Y(K,J)=Y(K,J)/EL
   31 CONTINUE
      PST=PST/EL
      FAL=FAL/EL
      FBL=FBL/EL
      FAY=FAY/EL
      FBY=FBY/EL
      CALL NILS(NOS,MS,ST,DS,JFK)
      IF(JFK.GT.0) GO TO 76
```

```
      ID=-1
      GO TO 77
   76 IF(OMIN.LE.0.0.OR.JA.EQ.3) GO TO 77
C
C    TRANSFER TO LOOP TO CALL PGM2 AND PGM3
C
      CALL AETSKC(5LPGM1A)
C
 77   CONTINUE
      IF(ID.EQ.2 .OR. ID.EQ.-1) CALL AETSKC(5LMOT35)
      CALL AETSKC(4LPGM4)
      END
```

```
      OVERLAY(3,0)
      PROGRAM PGM1B
C
C
      COMMON/HP1/  NPAG,TITLE(8),PATT(7),RATIO
      COMMON/HP2/  ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/HP3/  NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X             AVBM(30),ST(30),IN(30),SQAR(30),X(30,20),Y(30,20)
      COMMON/HP4/  NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/HP5/  VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/HP6/  NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/HP7/  NFN,NFNS,FN(6),FNS(6)
      COMMON/HP8/  NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/HP9/  NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/HP10/ XZFO,XZVL,XZHB,XZPB,KV,KW
      COMMON/HP11/ CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/HP12/ CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/HP13/ GRAV,DEPCAT,SD(6),RBMST(10)
      COMMON/HP14/ EL,GCB,GYR,RGY,VCG,BRCL,RF33,RP35,RM55
      COMMON/HP15/ A33(30),A35(4,30),A53(4,30),A55(4,30),C35S,C55S,
     X             B33(4,30,3),B35(4,30,3),B53(4,30,3),B55(4,30,3)
      COMMON/HP16/ AHP(30),DHP(4,30),AP(30),DP(4,30)
      COMMON/HP17/ OMEGA,UN,PAH(19),PVH(19)
      COMMON/HP18/ BLOG(19,19),YLOG(19,19)
      COMMON/HP19/ KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/HP20/ II,EFH(4,30,3),EMP(4,30,3),EMK(4,30,3)
      COMPLEX II,EFH,EMP
C
C   END OF COMMON DECK
C      (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
      CON=1.688
      IF(GRAV.LT.32.) CON=.3048*CON
      CON=SQRT(GRAV*EL)/CON
      FACT=SQRT(GRAV/EL)
      FARD=0.017453293
      BSD=BEAM(MS)*EL
      DO 205 ISD=1,NSD
      HHS=2.0*(SD(ISD))-BSD
      IF(BSD .LE. 1.E-07) GO TO 88
      RATIO=HHS/BSD
      GO TO 87
   88 RATIO=HHS
   87 IF(MONO .GE. 1) RATIO=0.
      SD(ISD)=SD(ISD)/EL
      IF(ISD.GT.1) FAY=FAY+SD(ISD)-SD(ISD-1)
      IF(ISD.GT.1) FBY=FBY+SD(ISD)-SD(ISD-1)
      CALL AETSKC(5LQPGM2)
      IF(ID.GT.1) GO TO 77
      CALL AETSKC(6LQPGM2B)
```

```
      IF(ID.GT.1) GO TO 77
      CALL AETSKC(5LQPGM3)
      IF(NOW.GT.0) GO TO 77
    5 FORMAT(1H1,14A6,18X,A6,I4/)
  172 FORMAT(5X,*RELATIVE AND ABSOLUTE DISPLACEMENT, VELOCITY, AND*,
     X * ACCELERATION AT STATION *,F5.1)
  173 FORMAT(3X,*SPEED =*,F5.1,* KNOTS*)
  175 FORMAT(3X,*ENC PER(SEC)*,6X,*REL DISPL*,6X,*ABS DISPL*,12X,
     X *VEL*,8X,*ACCEL/G*,7X,*WAVE L/L*)
  177 FORMAT(5X,F10.2,4(7X,F8.3),5X,F10.4)
  171 FORMAT(3X,*WAVE HEADING =*,F6.2,* DEGREES*/)
      DO 150 KI=1,NSTR
      RBMSTK=RBMST(KI)
      LINES=3
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,172) RBMSTK
      ARM=EL*(PST-.05*RBMSTK)
      DO 160 MM=1,NBTA
      COSB=COSBET(MM)
      DO 160 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 160
      LINES=LINES+LMT+4
      IF(LINES.LE.60) GO TO 140
      LINES=3
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,172) RBMSTK
  140 SPID=FN(JJ)*CON
      WRITE (6,173) SPID
      WRITE(6,171) WANG(MM)
      WRITE(6,175)
      DO 170 N=1,LMT
      WAVEN=FACT*WFR(JJ,N,MM)
      WAVEN=COSB*WAVEN*WAVEN/GRAV
      HEAVE = REAL(EFH(JJ,N,MM))
      DELTA = FARD*AIMAG(EFH(JJ,N,MM))
      PITCH = REAL (EMP(JJ,N,MM))*2./EL
      EPSIL = FARD*AIMAG(EMP(JJ,N,MM))
      ABMA=HEAVE*COS(DELTA)-ARM*PITCH*COS(EPSIL)
      ABMB=HEAVE*SIN(DELTA)-ARM*PITCH*SIN(EPSIL)
      ABMO=SQRT(ABMA**2 + ABMB**2)
      RLMA=ABMA -COS(ARM*WAVEN)
      RLMB=ABMB + SIN(ARM*WAVEN)
      RLMO=SQRT(RLMA**2 + RLMB**2)
      OMEGAE=OMEN(N)*FACT
      ENCP=6.2831853/OMEGAE
      VEL=OMEGAE*ABMO
      ACCEL=OMEGAE*VEL/GRAV
  170 WRITE(6,177) ENCP,RLMO,ABMO,VEL,ACCEL,RWS(JJ,N,MM)
  160 CONTINUE
  150 CONTINUE
```

```
      IJ=1
77    CONTINUE
      IF(IND.LE.0) GO TO 78
      DO 81 JJ=1,NFN
      DO 81 N=1,NFR
      DO 81 MM=1,NBTA
   81 EMP(JJ,N,MM)=EMK(JJ,N,MM)+II*AIMAG(EMP(JJ,N,MM))
      WRITE(22) NFN,NFR,NBTA
      WRITE(22) (FN(I),I=1,NFN),(OMEN(I),I=1,NFR),(WANG(I),I=1,NBTA)
      WRITE(22) (((WFR(JJ,N,MM),EFH(JJ,N,MM),EMP(JJ,N,MM),JJ=1,NFN),
     X N=1,NFR),MM=1,NBTA)
   78 IF(JA.EQ.2) CALL AETSKC(5LPGM1A)
      IF(ID.EQ.2 .OR. ID.EQ.-1) CALL AETSKC(5LMOT35)
      IF(LP.EQ.0 .AND. IP.EQ.0 .AND. NOW.EQ.0) CALL AETSKC(5LMOT35)
      IF(LP.EQ.0 .AND. IP.EQ.0) CALL AETSKC(4LPGM5)
  205 CONTINUE
      END
```

```
      PROGRAM QPGM2
C
      COMMON/HP1/  NPAG,TITLE(8),PATT(7),RATIO
      COMMON/HP2/  ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/HP3/  NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X             AVBM(30),ST(30),IN(30),SQAR(30),X(30,20),Y(30,20)
      COMMON/HP4/  NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/HP5/  VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/HP6/  NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/HP7/  NFN,NFNS,FN(6),FNS(6)
      COMMON/HP8/  NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/HP9/  NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/HP10/ XZFO,XZVL,XZHB,XZPB,KV,KW
      COMMON/HP11/ CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/HP12/ CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/HP13/ GRAV,DEPCAT,SD(6),RBMST(10)
      COMMON/HP14/ EL,GCB,GYR,RGY,VCG,BRCL,RF33,RP35,RM55
      COMMON/HP15/ A33(30),A35(4,30),A53(4,30),A55(4,30),C35S,C55S,
     X             B33(4,30,3),B35(4,30,3),B53(4,30,3),B55(4,30,3)
      COMMON/HP16/ AHP(30),DHP(4,30),AP(30),DP(4,30)
      COMMON/HP17/ OMEGA,UN,PAH(19),PVH(19)
      COMMON/HP18/ BLOG(19,19),YLOG(19,19)
      COMMON/HP19/ KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/HP20/ II,EFH(4,30,3),EMP(4,30,3),EMK(4,30,3)
      COMPLEX II,EFH,EMP
C
C    END OF COMMON DECK
C       (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
    1 FORMAT(6X,*DYNAMIC COEFFICIENTS OF THE EQUATIONS OF MOTION*////
     X  6X,*A33 IS SCALED BY M.*//
     X  6X,*A35 AND A53 ARE SCALED BY *,4HM*L.//
     X  6X,*A55 IS SCALED BY M*,5H*L*L.//
     X  6X,*B33 IS SCALED BY M*,1H*,*SQRT(G/L).*//
     X  6X,*B35 AND B53 ARE SCALED BY M*,11H*SQRT(G*L).//
     X  6X,*B55 IS SCALED BY M*,13H*L*SQRT(G*L).//
     X  6X,*M IS THE DISPLACED MASS.*//
     X  6X,*G IS THE ACCELERATION DUE TO GRAVITY.*//
     X  6X,*L IS THE DISTANCE BETWEEN PERPENDICULARS.*////
     X  6X,*FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT*,6H(G*L).//
     X  6X,*BETA IS THE WAVE HEADING ANGLE IN DEGREES.*/
     X  6X,*BETA = 180. FOR HEAD SEAS.*//
     X  6X,*OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED BY*,
     X  *SQRT(G/L).*//
     X  6X,*THE HULL SEPARATION/BEAM RATIO IS THE DISTANCE*/
     X  6X,*BETWEEN THE HULLS DIVIDED BY THE BEAM OF ONE HULL.*)
    2 FORMAT(1H0,5X,*BARE HULL POTENTIAL FLOW ADDED MASS AND DAMPING*,
     X  * COEFFICIENTS*/6X,*FN = *,F5.3/
     X  10X,*OMEGA*,7X,*A33*,7X,*A35*,7X,*A53*,7X,*A55*,7X,*B33*,7X,
     X  *B35*,7X,*B53*,7X,*B55*)
```

```
  3 FORMAT(F15.4,6F10.6)
  4 FORMAT(1H0,5X,*ADDED MASS COEFFICIENTS AND DAMPING COEFFICIENTS*
   X  * EXCLUDING CROSS-FLOW DRAG*/6X,*FN = *,F5.3/
   X  10X,*OMEGA*,7X,*A33*,7X,*A35*,7X,*A53*,7X,*A55*,7X,*B33*,7X,
   X  *B35*,7X,*B53*,7X,*B55*)
  5 FORMAT(1H1,14A6,18X,A6,I4/)
  6 FORMAT(F15.4,8F10.6)
 11 FORMAT(1H0,5X,8HSTATION F7.4)
150 FORMAT(1H0,80X,*HULL SEPARATION/BEAM = *,F7.4)
205 FORMAT(1H0,5X,43HPROJECTED AREA OF THE SUBMERGED HULL/L**2 =,E15.6
   1/5X,13HMOMENT/L**3 =,E15.6,5X,24HMOMENT OF INERTIA/L**4 =,E15.6)
    IF(1.EQ.0) CALL PGM1B
    FALP=PST-FAL
    FBLP=PST-FBL
    QPI = 0.7853982
    RVOL = VOL * EL**3
    NSO=NOS
    II=(0.0,1.0)
    DO 12 MM=1,NBTA
    WAND=WANG(MM)*.01745329252
    COSBET(MM)=COS(WAND)
 12 SINBET(MM)=SIN(WAND)
    CALL QDFCN
    DO 25 JJ=1,NFN
    LMT=MIL(JJ)
    IF(MIL(JJ).LE.0) GO TO 25
    DO 20 N=1,LMT
    DO 20 MM=1,NBTA
 20 RWS(JJ,N,MM)=1./SWR(JJ,N,MM)
 25 CONTINUE
    DO 40 N=1,NFR
    A33(N)=0.0
    AHP(N)=0.0
     AP(N)=0.0
 40 CONTINUE
    DO 50 JJ=1,NFN
    DO 50 N=1,NFR
    DHP(JJ,N) = 0.0
    DP(JJ,N)=0.0
    B33(JJ,N,1)=0.
    DO 50 MM=1,NBTA
    EFH(JJ,N,MM)=(0.,0.)
 50 EMP(JJ,N,MM)=(0.,0.)
    PROA=0.
    PROM=0.
    PROI=0.
    DO 60 K=1,NOS
    XIP=PST-SS(K)
    XIP2=XIP*XIP
    DST=DS(K)
    NUT=NM(K)
    IF(NUT .EQ. 0) GO TO 60
    DO 333 IJK=1,NUT
333 XS(IJK)=X(K,IJK)
```

```
      XLG=XMAX(NUT,XS)
      XSM=XMIN(NUT,XS)
      AVBM(K)=XLG-XSM
      BAM=BEAM(K)
      DRT=DRFT(K)
      AIR=AREA(K)
      DA=DST*AVBM(K)
      PROA=PROA+DA
      PROM=PROM-XIP*DA
      PROI=PROI+XIP2*DA
      NON=NUT-1
      NOE=2*NON
      DO 62 J=1,NUT
      XS(J)=X(K,J)+SD(ISD)
   62 YS(J)=Y(K,J)
      YSML = XMIN(NUT,YS)
      DO 65  IJI = 1, NUT
      NNN = IJI
      IF(YSML.EQ.YS(IJI)) GO TO 66
   65 CONTINUE
   66 MAXD = NNN
      IF(MONO .GT. 1) MAXD=1
      DO 63 J=1,NON
      XX(J)=0.5*(XS(J)+XS(J+1))
      YY(J)=0.5*(YS(J)+YS(J+1))
      XINT=XS(J+1)-XS(J)
      YINT=YS(J+1)-YS(J)
      DEL(J)=SQRT(XINT**2+YINT**2)
      SNE(J)=YINT/DEL(J)
   63 CSE(J)=XINT/DEL(J)
      CALL FRANK
      IF(ID.LT.2) GO TO 60
      STATION=20.0*SS(K)
      WRITE(6,11)STATION
      GO TO 77
   60 CONTINUE
      WRITE(6,205) PROA,PROM,PROI
      DO 30 N=1,NFR
      GXI=OMEN(N)
      DEB=GXI*VOL
      DEA=GXI*DEB
      A33(N)=A33(N)/DEA
      AHP(N)=AHP(N)/DEA
      AP(N)=AP(N)/DEA
      DO 30 JJ=1,NFN
      B33(JJ,N,1)=B33(JJ,N,1)/DEB
      DHP(JJ,N)=DHP(JJ,N)/DEB
   30 DP(JJ,N)=DP(JJ,N)/DEB
      DO 31 N=1,NFR
      GXI=OMEN(N)
      GX2=GXI*GXI
      A33N=A33(N)
      A35N=AHP(N)
      DO 31 JJ=1,NFN
```

```
      FNJ=FN(JJ)
      R55=FNJ*FNJ/GX2
      B33S=B33(JJ,N,1)
      SB=FNJ*B33S/GX2
      A35(JJ,N)=A35N-SB
      A53(JJ,N)=A35N+SB
      A55(JJ,N)=AP(N)+R55*A33N
      SA=DHP(JJ,N)
      SB=FNJ*A33N
      B35(JJ,N,1)=SA+SB
      B53(JJ,N,1)=SA-SB
      B55(JJ,N,1)=DP(JJ,N)+R55*B33S
   31 CONTINUE
      IF(IG.LT.2) GO TO 34
      NPAG=NPAG+1
      WRITE(6,5)  (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,150) RATIO
      WRITE(6,1)
      NPAG=NPAG+1
      WRITE(6,5)  (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,150) RATIO
      KR=0
      DO 33 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 33
      NF4=LMT+4
      WRITE(6,2) FN(JJ)
      WRITE(6,6)  (OMEN(N),A33(N),A35(JJ,N),A53(JJ,N),A55(JJ,N),
     X  B33(JJ,N,1),B35(JJ,N,1),B53(JJ,N,1),B55(JJ,N,1),N=1,LMT)
      IF(JJ.EQ.NFN) GO TO 33
      KR=KR+NF4
      IF(55-KR.GE.NF4) GO TO 33
      KR=0
      NPAG=NPAG+1
      WRITE(6,5)  (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,150) RATIO
   33 CONTINUE
   34 CONTINUE
      ADAB=AMAB=AIAB=0.
      VDAB=VMAB=VIAB=0.
      IFIN=0
      IF(CLFA.EQ.0. .AND. CLFB.EQ.0.) GO TO 67
      IFIN=1
      CSA=CHRDA*SPNA
      CSB=CHRDB*SPNB
      FALP2=FALP*FALP
      FBLP2=FBLP*FBLP
      ADFA=QPI*CSA*(CHRDA+THKA)/RVOL
      ADFB=QPI*CSB*(CHRDB+THKB)/RVOL
      ADAB=ADFA+ADFB
      AMAB=-FALP*ADFA-FBLP*ADFB
      AIAB=FALP2*ADFA+FBLP2*ADFB
   67 CON=.5*EL/RVOL
      CONA=CON*CSA*CLFA
```

```
      CONB=CON*CSB*CLFB
      CONV=.5*XZVL/VOL
      DO 70 N=1,NFR
      GX2=OMEN(N)
      GX2=GX2*GX2
      A33(N)=A33(N)+ADAB
      DO 70 JJ=1,NFN
      FNJ=FN(JJ)
      IF(IFIN.EQ.0) GO TO 68
      VDPA=CONA*FNJ
      VDPB=CONB*FNJ
      VDAB=VDPA+VDPB
      VMAB=-FALP*VDPA-FBLP*VDPB
      VIAB=FALP2*VDPA+FBLP2*VDPB
   68 VISF=CONV*FNJ
      R35=FNJ/GX2
      R55=FNJ*R35
      A35(JJ,N)=A35(JJ,N)+AMAB
      A53(JJ,N)=A53(JJ,N)+AMAB
      A55(JJ,N)=A55(JJ,N)+R55*ADAB+AIAB
      SB33=B33(JJ,N,1)+VISF*PROA+VDAB
      SA=FNJ*ADAB
      SB=VISF*PROM+VMAB
      SB35=B35(JJ,N,1)+SA+SB
      SB53=B53(JJ,N,1)-SA+SB
      SB55=B55(JJ,N,1)+VISF*PROI+VIAB
      DO 70 MM=1,NBTA
      B33(JJ,N,MM)=SB33
      B35(JJ,N,MM)=SB35
      B53(JJ,N,MM)=SB53
   70 B55(JJ,N,MM)=SB55
      C35S=CONV*PROA+CONA+CONB
      C55S=CONV*PROM-FALP*CONA-FBLP*CONB
      IF(IG.LT.2) GO TO 77
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,150)RATIO
      KR=0
      DO 95 JJ=1,NFN
      LMT=MIL(JJ)
      NF4=LMT+4
      IF(LMT.LE.0) GO TO 95
      WRITE(6,4) FN(JJ)
      WRITE(6,6) (OMEN(N),A33(N),A35(JJ,N),A53(JJ,N),A55(JJ,N),
     X  B33(JJ,N,1),B35(JJ,N,1),B53(JJ,N,1),B55(JJ,N,1),N=1,LMT)
      IF(JJ.EQ.NFN) GO TO 95
      KR=KR+NF4
      IF((55-KR).GE.NF4) GO TO 95
      KR=0
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,150)RATIO
   95 CONTINUE
   77 CONTINUE
      CALL AERTRNK
      END
```

```
      PROGRAM QPGM2B
C
      COMMON/HP1/  NPAG,TITLE(8),PATT(7),RATIO
      COMMON/HP2/  ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/HP3/  NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X             AVBM(30),ST(30),IN(30),SQAR(30),X(30,20),Y(30,20)
      COMMON/HP4/  NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/HP5/  VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/HP6/  NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/HP7/  NFN,NFNS,FN(6),FNS(6)
      COMMON/HP8/  NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/HP9/  NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/HP10/ XZFO,XZVL,XZHB,XZPB,KV,KW
      COMMON/HP11/ CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/HP12/ CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/HP13/ GRAV,DEPCAT,SD(6),RBMST(10)
      COMMON/HP14/ EL,GCB,GYR,RGY,VCG,BRCL,RF33,RP35,RM55
      COMMON/HP15/ A33(30),A35(4,30),A53(4,30),A55(4,30),C35S,C55S,
     X             B33(4,30,3),B35(4,30,3),B53(4,30,3),B55(4,30,3)
      COMMON/HP16/ AHP(30),DHP(4,30),AP(30),DP(4,30)
      COMMON/HP17/ OMEGA,UN,PAH(19),PVH(19)
      COMMON/HP18/ BLOG(19,19),YLOG(19,19)
      COMMON/HP19/ KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/HP20/ II,EFH(4,30,3),EMP(4,30,3),EMK(4,30,3)
      COMPLEX II,EFH,EMP
C
C     END OF COMMON DECK
C        (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
      COMPLEX EGH,ENP
      COMMON/PR23/ EGH(4,30,3),ENP(4,30,3)
C
      COMPLEX AVC,CA,CB,CCON,CEX,CEXAL,CEXBL,CPART,CPARTA,CPARTB,CPET,
     X  CZIH,CZIP,EXMN,EXPL,F3V,F5V,IKC,IKS,IKSS,IVISF,WEXMN,WEXPL
      COMPLEX SEFH(4,30,3),SEMP(4,30,3)
C
      DIMENSION DTMA(30),EPK(4,30,3)
    2 FORMAT(1H0,5X,*DAMPING COEFFICIENTS INCLUDING CROSS-FLOW DRAG*/
     X   6X,*FN = *,F5.3//13X,*BETA = *,F6.1/
     X   6X,*OMEGA*,7X,*B33*,7X,*B35*,7X,*B53*,7X,*B55*)
    3 FORMAT(1H0,5X,*DAMPING COEFFICIENTS INCLUDING CROSS-FLOW DRAG*/
     X   6X,*FN = *,F5.3//13X,*BETA = *,F6.1,27X,*BETA = *,F6.1/
     X   6X,*OMEGA*,2(7X,*B33*,7X,*B35*,7X,*B53*,7X,*B55*))
    4 FORMAT(1H0,5X,*DAMPING COEFFICIENTS INCLUDING CROSS-FLOW DRAG*/
     X   6X,*FN = *,F5.3//13X,*BETA = *,F6.1,2(27X,*BETA = *,F6.1)/
     X   6X,*OMEGA*,3(7X,*B33*,7X,*B35*,7X,*B53*,7X,*B55*))
    5 FORMAT(1H1,14A6,18X,A6,I4/)
    6 FORMAT(1H0,5X,*EXCITING FORCE, MOMENT AND PHASES*////
     X   6X,*THE FORCE AMPLITUDE IS SCALED BY THE HEAVE RESTORING FORCE*/
     X   6X,*C33 = RHO*,5H*G*A*,*(WATERPLANE AREA).*//
```

```
  X   6X,*THE MOMENT AMPLITUDE IS SCALED BY THE PITCH RESTORING *,
  X   *MOMENT*/6X,*C55 = RHO*,5H*G*A*,*(MOMENT OF INERTIA OF*,
  X   * WATERPLANE)/L.*//
  X   6X,1H*,*MOMENT DENOTES THE MOMENT AMPLITUDE SCALED BY L*,1H*,
  X   *(WAVE NUMBER)*,1H*,*C55.*//
  X   6X,*G IS THE ACCELERATION DUE TO GRAVITY.*//
  X   6X,*A IS THE WAVE AMPLITUDE.*//
  X   6X,*L IS THE DISTANCE BETWEEN PERPENDICULARS.*//
  X   6X,*RHO IS THE WATER DENSITY.*///)
 7 FORMAT(6X,*FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT*,
  X   6H(G*L).//
  X   6X,*BETA IS THE WAVE HEADING ANGLE IN DEGREES.*/
  X   6X,*BETA = 180. FOR HEAD SEAS.*//
  X   6X,*OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED BY*,
  X   * SQRT(G/L).*//
  X   6X,*THE PHASE ANGLE IS MEASURED IN DEGREES WITH RESPECT TO THE*,
  X   * WAVE AT THE CG. *//
  X   6X,*L/LAM IS L/(WAVE LENGTH).*//
  X   6X,*FOR FOLLOWING SEAS THE FREQUENCY DOMAIN IS DIVIDED INTO *,
  X   *THREE*/6X,*REGIONS SEPARATED BY TWO CRITICAL L/LAM DENOTED *,
  X   *CWR1 AND CWR2.*)
 8 FORMAT(1H0,5X,*EXCITING FORCE, MOMENT AND PHASES*/
  X   6X,*FN = *,F5.3/6X,*BETA = *,F6.1/
  X   6X,*REGION *,I1,*CWR1 = *,F9.4,* CWR2 = *,F9.4//
  X   6X,*OMEGA*,5X,*L/LAM*,5X,*FORCE*,5X,*PHASE*,4X,*MOMENT*,5X,
  X   *PHASE*,3X,7H*MOMENT,5X,*LAM/L*)
 9 FORMAT(1H0,5X,*EXCITING FORCE, MOMENT AND PHASES*/
  X   6X,*FN = *,F5.3/6X,*BETA = *,F6.1//
  X   6X,*OMEGA*,5X,*L/LAM*,5X,*FORCE*,5X,*PHASE*,4X,*MOMENT*,5X,
  X   *PHASE*,3X,7H*MOMENT,5X,*LAM/L*)
10 FORMAT(F11.4,F10.4,F10.5,F10.3,F10.5,F10.3,F10.5,F10.4)
12 FORMAT(1X,F10.4,4F10.6)
13 FORMAT(1X,F10.4,8F10.6)
14 FORMAT(1X,F10.4,12F10.6)
150 FORMAT(1H0,80X,*HULL SEPARATION/BEAM = *,F7.4)
202 FORMAT(6X,*FN = *,F5.3/6X,*BETA = *,F6.1/10X,*OMEGA*,5X,*HEAVE*,
  X   5X,*PHASE*,5X,*PITCH*,5X,*PHASE*,5X,*LAM/L*)
203 FORMAT((5X,F10.3,2(F10.5,F10.3),F10.4))
204 FORMAT(6X,*EQUATIONS OF MOTION SOLVED USING DAMPING*,
  X   * COEFFICIENTS EXCLUDING CROSS-FLOW DRAG.*)
205 FORMAT(6X,*EQUATIONS OF MOTION SOLVED USING EXCITING FORCE*,
  X   * INCLUDING FIN AND BODY LIFT CONTRIBUTIONS.*)
206 FORMAT(6X,*EQUATIONS OF MOTION SOLVED WITH VISCOUS*,
  X   * CROSS-FLOW DAMPING EFFECTS.*)
500 FORMAT(5X,*MOTION AMP FAILED TO CONVERGE FOR BETA =*,F8.2,
  X   *FN =*,F8.4,*  LAST 2 VALUES =*,E12.5,* AND*,E12.5,
  X   *CALCULATION CONTINUES.*)
501 FORMAT(5X,*ITERATION NOT USED.  MAX AMP =*,E12.5)
502 FORMAT(1X,I2)
    IF(1.EQ.0) CALL PGM1B
    SDI=SD(ISD)
    DVOL=1./VOL
    IF(IG.NE.3) GO TO 29
    CALL SOLVE(2,DVOL,DVOL,1,NFN,1,NBTA,1,NFR)
```

```
      KR=0
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,150) RATIO
      WRITE(6,204)
      DO 28 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 28
      LMP=LMT+5
      DO 27 MM=1,NBTA
      IF(55-KR.GE.LMP) GO TO 26
      KR=0
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,150) RATIO
      WRITE(6,204)
   26 WRITE(6,202) FN(JJ),WANG(MM)
      WRITE(6,203) (OMEN(N),EGH(JJ,N,MM),ENP(JJ,N,MM),RWS(JJ,N,MM),
     X  N=1,LMT)
      KR=KR+LMP
   27 CONTINUE
   28 CONTINUE
   29 CONTINUE
      ELEL=EL*EL
      EL3=ELEL*EL
      RVOL=EL3*VOL
      DEPAL=DEPA/EL
      DEPBL=DEPB/EL
      DEPCAL=DEPCAT/EL
      FALP=PST-FAL
      FBLP=PST-FBL
      FALP2=FALP*FALP
      FBLP2=FBLP*FBLP
      CSCA=.5*CHRDA*SPNA*CLFA
      CSCB=.5*CHRDB*SPNB*CLFB
      IF(CLFA.LE.0. .AND. CLFB.LE.0. .AND. XZVL.EQ.0.) GO TO 399
      DO 80 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 80
      FNJ=FN(JJ)
      IVISF=.5*II*FNJ*XZVL
      FNJ=FNJ/ELEL
      DO 81 MM=1,NBTA
      COSB=COSBET(MM)
      SINB=SINBET(MM)
      SSINB=SDI*SINB
      DO 81 N=1,LMT
      CAY=WN(JJ,N,MM)
      F3V=(0.,0.)
      F5V=(0.,0.)
      IKC=II*CAY*COSB
      EKD=EXP(-CAY*DEPCAL)
      DO 75 K=1,NOS
      XIP=PST-SS(K)
```

```
      IF(DEPCAT.EQ.0.) EKD=EXP(-CAY*AREA(K)*DRFT(K))
      CPET=EKD*AVBM(K)*CEXP(IKC*XIP)*DS(K)
      F3V=F3V-CPET
   75 F5V=F5V+XIP*CPET
      CCON=IVISF*WFR(JJ,N,MM)*COS(CAY*SSINB)
      CAYB=CAY*SINB
      FEXF=FNJ*WFR(JJ,N,MM)
      CA=-II*FEXF*CSCA*EXP(-CAY*DEPAL)*COS(CAYB*FAY)*CEXP(IKC*FALP)
      CB=-II*FEXF*CSCB*EXP(-CAY*DEPBL)*COS(CAYB*FBY)*CEXP(IKC*FBLP)
      EFH(JJ,N,MM)=EFH(JJ,N,MM)+CA+CB+CCON*F3V
   81 EMP(JJ,N,MM)=EMP(JJ,N,MM)-FALP*CA-FBLP*CB+CCON*F5V
   80 CONTINUE
      IF(IG.NE.3) GO TO 39
      CALL SOLVE(2,DVOL,DVOL,1,NFN,1,NBTA,1,NFR)
      KR=0
      NPAG=NPAG+1
      WRITE(6,5)  (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,150) RATIO
      WRITE(6,205)
      DO 38 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 38
      LMP=LMT+5
      DO 37 MM=1,NBTA
      IF(55-KR.GE.LMP) GO TO 31
      KR=0
      NPAG=NPAG+1
      WRITE(6,5)  (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,150) RATIO
      WRITE(6,205)
   31 WRITE(6,202) FN(JJ),WANG(MM)
      WRITE(6,203)  (OMEN(N),EGH(JJ,N,MM),ENP(JJ,N,MM),RWS(JJ,N,MM),
     X  N=1,LMT)
      KR=KR+LMP
   37 CONTINUE
   38 CONTINUE
   39 CONTINUE
  399 IF(XZVL+XZFO+XZFA+XZFB.GT.0.) GO TO 34
      DO 36 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 36
      DO 35 N=1,LMT
      DO 35 MM=1,NBTA
      EFH(JJ,N,MM)=EFH(JJ,N,MM)/AMP1
   35 EMP(JJ,N,MM)=EMP(JJ,N,MM)/AMP2
   36 CONTINUE
      GO TO 76
   34 CON=(-CSCA*FALP-CSCB*FBLP)*EL/RVOL
      DO 51 JJ=1,NFN
      DO 51 N=1,NFR
      EPK(JJ,N,1)=B33(JJ,N,1)
      EPK(JJ,N,2)=B35(JJ,N,1)
      EPK(JJ,N,3)=B53(JJ,N,1)
   51 DP(JJ,N)=B55(JJ,N,1)
```

```
      DO 714 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 714
      DO 713 MM=1,NBTA
      ILOOP=-1
      DO 53 N=1,LMT
      SEFH(JJ,N,MM)=EFH(JJ,N,MM)/AMP1
   53 SEMP(JJ,N,MM)=EMP(JJ,N,MM)/AMP2
  555 ILOOP=ILOOP+1
      IF(ILOOP.LE.0) GO TO 52
      DO 56 N=1,LMT
      EFH(JJ,N,MM)=EFH(JJ,N,MM)*AMP1
   56 EMP(JJ,N,MM)=EMP(JJ,N,MM)*AMP2
   52 CALL SOLVE(2,DVOL,DVOL,JJ,JJ,MM,MM,1,LMT)
      IF(IG.NE.3) GO TO 25
      KR=0
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,150) RATIO
      WRITE(6,206)
      LMP=LMT+4
      IF(55-KR.GE.LMP) GO TO 24
      KR=0
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,150) RATIO
      WRITE(6,206)
   24 WRITE(6,202) FN(JJ),WANG(MM)
      WRITE(6,203) (OMEN(N),EGH(JJ,N,MM),ENP(JJ,N,MM),
     X  RWS(JJ,N,MM),N=1,LMT)
      KR=KR+LMP
   25 IF(NLOOP.LE.1) GO TO 55
      DO 54 N=1,LMT
   54 DTMA(N)=REAL(EGH(JJ,N,MM))
      EGHMXL=EGHMX
      EGHMX=XMAX(LMT,DTMA)
      IF(EGHMX.LT..8) GO TO 556
      IF(ILOOP.LE.0) GO TO 55
      IF(ABS(EGHMX-EGHMXL)/EGHMXL.LE.1) GO TO 557
   55 CSXA=CHRDA*SPNA*XZFA
      CSXB=CHRDB*SPNB*XZFB
C    .21221=2/(3*PI)
C    .005=A/EL=EMPIRICAL FACTOR
C    XZFOC=(.005*EL)*.21221*XZFO/EL
      XZFOC=.001061*XZFO
      VISM=XZFOC/VOL
      DO 712 N=1,LMT
      GXI=OMEN(N)
      VISP=VISM*GXI
      EFH(JJ,N,MM)=EFH(JJ,N,MM)/AMP1
      EMP(JJ,N,MM)=EMP(JJ,N,MM)/AMP2
      ZRH=REAL(EGH(JJ,N,MM))
      ZRP=REAL(ENP(JJ,N,MM))
      ZIH=AIMAG(EGH(JJ,N,MM))/57.295779
      ZIP=AIMAG(ENP(JJ,N,MM))/57.295779
```

```
      CZIH=ZRH*CEXP(-II*ZIH)
      CZIP=2.*ZRP*CEXP(-II*ZIP)
      CAY=WN(JJ,N,MM)
      OMEW=WFR(JJ,N,MM)
      PROA=0.
      PROM=0.
      PROI=0.
      F3V=(0.,0.)
      F5V=(0.,0.)
      WDW=OMEW/GXI
      IKS=II*CAY
      IKC=IKS*COSBET(MM)
      IKS=IKS*SINBET(MM)
      IKSS=IKS*SDI
      EXPL=CEXP(IKSS)
      EXMN=CEXP(-IKSS)
      WEXPL=WDW*EXPL
      WEXMN=WDW*EXMN
      EKD=EXP(-CAY*DEPCAL)
      DO 575 K=1,NOS
      AVB=AVBM(K)
      DST=DS(K)
      XIP=PST-SS(K)
      IF(DEPCAT.EQ.0.) EKD=EXP(-CAY*AREA(K)*DRFT(K))
      CEX=EKD*CEXP(IKC*XIP)
      CPART=CZIH-CZIP*XIP
      VZEROP=CABS(CPART-WEXPL*CEX)
      VZEROM=CABS(CPART-WEXMN*CEX)
      AVV=AVB*(VZEROP+VZEROM)*DST
      PROA=PROA+AVV
      AVV=XIP*AVV
      PROM=PROM+AVV
      PROI=PROI+XIP*AVV
      AVC=AVB*CEX*(VZEROP*EXPL+VZEROM*EXMN)*DST
      F3V=F3V+AVC
  575 F5V=F5V+XIP*AVC
      EKDA=EXP(-CAY*DEPAL)
      EKDB=EXP(-CAY*DEPBL)
      CEXAL=WDW*EKDA*CEXP(IKC*FALP)
      CEXBL=WDW*EKDB*CEXP(IKC*FBLP)
      CPARTA=CZIH-FALP*CZIP
      CPARTB=CZIH-FBLP*CZIP
      IKSS=IKS*FAY
      PARTA=CABS(CPARTA-CEXAL*CEXP(IKSS))+CABS(CPARTA-CEXAL*CEXP(IKSS))
      IKSS=IKS*FBY
      PARTB=CABS(CPARTB-CEXBL*CEXP(IKSS))+CABS(CPARTB-CEXBL*CEXP(-IKSS))
      CON=.21221*GXI/RVOL
      VDPA=CON*CSXA*PARTA
      VDPB=CON*CSXB*PARTB
      CON=.21221*GXI*GXI/EL3
      PARTA=CON*CSXA*PARTA
      PARTB=CON*CSXB*PARTB
      CON=XZFOC*GXI*OMEW
      EFH(JJ,N,MM)=SEFH(JJ,N,MM)+II*(-CON*F3V-PARTA*CEXAL-PARTB*CEXBL)/
     X  AMP1
```

```
      EMP(JJ,N,MM)=SEMP(JJ,N,MM)+II*(CON*F5V+FALP*PARTA*CEXAL+FBLP*
     X  PARTB*CEXBL)/AMP2
      B33(JJ,N,MM)=EPK(JJ,N,1)+VISP*PROA+VDPA+VDPB
      CON=-VISP*PROM-VDPA*FALP-VDPB*FBLP
      B35(JJ,N,MM)=EPK(JJ,N,2)+CON
      B53(JJ,N,MM)=EPK(JJ,N,3)+CON
  712 B55(JJ,N,MM)=DP(JJ,N)+VISP*PROI+FALP2*VDPA+FBLP2*VDPB
      IF(NLOOP.LE.1) GO TO 713
      IF(ILOOP.LE.NLOOP) GO TO 555
      WRITE(6,500) WANG(MM),FN(JJ),EGHMXL,EGHMX
      GO TO 558
  556 WRITE(6,501) EGHMX
  557 DO 715 N=1,LMT
      EFH(JJ,N,MM)=EFH(JJ,N,MM)/AMP1
  715 EMP(JJ,N,MM)=EMP(JJ,N,MM)/AMP2
  558 WRITE(6,502) ILOOP
  713 CONTINUE
  714 CONTINUE
   76 IF(IG.LE.0) GO TO 77
      DO 85 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 85
      DO 84 MM=1,NBTA
      DO 84 N=1,LMT
      ZRH=CABS(EFH(JJ,N,MM))
      ZRP=CABS(EMP(JJ,N,MM))
      IF(ZRH.LE.0.) GO TO 87
      ZIH=-57.295779*ATAN2(AIMAG(EFH(JJ,N,MM)),REAL(EFH(JJ,N,MM)))
      IF(ZIH.GT.90.) ZIH=ZIH-360.
      EGH(JJ,N,MM)=CMPLX(ZRH,ZIH)
      GO TO 88
   87 EGH(JJ,N,MM)=(0.,0.)
   88 IF(ZRP.LE.0.) GO TO 90
      ZIP=-57.295779*ATAN2(AIMAG(EMP(JJ,N,MM)),REAL(EMP(JJ,N,MM)))
      IF(ZIP.LT.-270.) ZIP=ZIP+360.
      ENP(JJ,N,MM)=CMPLX(ZRP,ZIP)
      EPK(JJ,N,MM)=ZRP/WN(JJ,N,MM)
      GO TO 84
   90 ENP(JJ,N,MM)=(0.,0.)
      EPK(JJ,N,MM)=0.
   84 CONTINUE
   85 CONTINUE
      IF(IG.LT.2) GO TO 111
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,150) RATIO
      KR=0
      NFP=NFR+5
      DO 40 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 40
      GO TO(41,42,43), NBTA
   41 WRITE(6,2) FN(JJ),WANG(1)
      WRITE(6,12) (OMEN(N),B33(JJ,N,1),B35(JJ,N,1),B53(JJ,N,1),
     X  B55(JJ,N,1),N=1,LMT)
```

```
      GO TO 45
   42 WRITE(6,3) FN(JJ),WANG(1),WANG(2)
      WRITE(6,13) (OMEN(N),(B33(JJ,N,MM),B35(JJ,N,MM),B53(JJ,N,MM),
     X  B55(JJ,N,MM),MM=1,2),N=1,LMT)
      GO TO 45
   43 WRITE(6,4) FN(JJ),(WANG(I),I=1,3)
      WRITE(6,14) (OMEN(N),(B33(JJ,N,MM),B35(JJ,N,MM),B53(JJ,N,MM),
     X  B55(JJ,N,MM),MM=1,3),N=1,LMT)
   45 IF(JJ.EQ.NFN) GO TO 40
      KR=KR+NFP
      IF(55-KR.GE.NFP) GO TO 40
      KR=0
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,150) RATIO
   40 CONTINUE
  111 NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,150) RATIO
      WRITE(6,6)
      WRITE(6,7)
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,150) RATIO
      KR=0
      DO 100 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 100
      LMP=LMT+5
      IF(KASE(JJ).NE.0) LMP=LMP+1
      DO 110 MM=1,NBTA
      IF(55-KR.GE.LMP) GO TO 103
      KR=0
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,150) RATIO
  103 IF(KASE(JJ).EQ.0) GO TO 101
      WRITE(6,8) FN(JJ),WANG(MM),KASE(JJ),CWR1(JJ),CWR2(JJ)
      GO TO 102
  101 WRITE(6,9) FN(JJ),WANG(MM)
  102 WRITE(6,10) (OMEN(N),SWR(JJ,N,MM),EGH(JJ,N,MM),ENP(JJ,N,MM),
     X  EPK(JJ,N,MM),RWS(JJ,N,MM),N=1,LMT)
      KR=KR+LMP
  110 CONTINUE
  100 CONTINUE
   77 CONTINUE
      CALL AERTRNK
      END
```

```
      SUBROUTINE SOLVE(IOPT,CONEFH,CONEMP,IFNF,IFNL,IBTAF,IBTAL,
     X                IFRF,IFRL)
C
      COMMON/HP1/  NPAG,TITLE(8),PATT(7),RATIO
      COMMON/HP2/  ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/HP3/  NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X             AVBM(30),ST(30),IN(30),SQAR(30),X(30,20),Y(30,20)
      COMMON/HP4/  NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/HP5/  VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/HP6/  NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/HP7/  NFN,NFNS,FN(6),FNS(6)
      COMMON/HP8/  NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/HP9/  NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/HP10/ XZFO,XZVL,XZHB,XZPB,KV,KW
      COMMON/HP11/ CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/HP12/ CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/HP13/ GRAV,DEPCAT,SD(6),RBMST(10)
      COMMON/HP14/ EL,GCB,GYR,RGY,VCG,BRCL,RF33,RP35,RM55
      COMMON/HP15/ A33(30),A35(4,30),A53(4,30),A55(4,30),C35S,C55S,
     X             B33(4,30,3),B35(4,30,3),B53(4,30,3),B55(4,30,3)
      COMMON/HP16/ AHP(30),DHP(4,30),AP(30),DP(4,30)
      COMMON/HP17/ OMEGA,UN,PAH(19),PVH(19)
      COMMON/HP18/ BLOG(19,19),YLOG(19,19)
      COMMON/HP19/ KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/HP20/ II,EFH(4,30,3),EMP(4,30,3),EMK(4,30,3)
      COMPLEX II,EFH,EMP
C
C     END OF COMMON DECK
C        (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
      COMPLEX EGH,ENP
      COMMON/PR23/ EGH(4,30,3),ENP(4,30,3)
      DIMENSION TOD(4,4),BOD(4,1),INDEX(4,3)
C
      DO 10 JJ=IFNF,IFNL
      LMT=MIL(JJ)
      IF(LMT.LT.IFRF) GO TO 10
      IFRLL=IFRL
      IF(LMT.LT.IFRL) IFRLL=LMT
      FNJ2=FN(JJ)**2
      C35=RP35+FNJ2*C35S
      C55=RM55+FNJ2*C55S
      DO 20 N=IFRF,IFRLL
      DO 30 MM=IBTAF,IBTAL
      GXI=OMEN(N)
      GX2=GXI*GXI
      TOD(1,1)=-GX2*(A33(N)+1.0)+RF33
      TOD(1,2)=-GX2*A35(JJ,N)+C35
      TOD(1,3)=GXI*B33(JJ,N,MM)
```

```
      TOD(1,4)=GXI*B35(JJ,N,MM)
      TOD(2,1)=-GX2*A53(JJ,N)+RP35
      TOD(2,2)=-GX2*(A55(JJ,N)+GYR)+C55
      TOD(2,3)=GXI*B53(JJ,N,MM)
      TOD(2,4)=GXI*B55(JJ,N,MM)
      TOD(3,1)=-TOD(1,3)
      TOD(3,2)=-TOD(1,4)
      TOD(3,3)=TOD(1,1)
      TOD(3,4)=TOD(1,2)
      TOD(4,1)=-TOD(2,3)
      TOD(4,2)=-TOD(2,4)
      TOD(4,3)=TOD(2,1)
      TOD(4,4)=TOD(2,2)
      BOD(1,1)=CONEFH*REAL(EFH(JJ,N,MM))
      BOD(2,1)=CONEMP*REAL(EMP(JJ,N,MM))
      BOD(3,1)=CONEFH*AIMAG(EFH(JJ,N,MM))
      BOD(4,1)=CONEMP*AIMAG(EMP(JJ,N,MM))
      CALL MATINS(TOD,4,4,BOD,1,1,DTRM,ID,INDEX)
      GO TO(32,33),ID
   33 EFH(JJ,N,MM)=(0.,0.)
      EMP(JJ,N,MM)=(0.,0.)
      IF(IOPT.EQ.3) EMK(JJ,N,MM)=0.
      GO TO 30
32    ZRH=SQRT(BOD(1,1)**2+BOD(3,1)**2)
      ZIH=-57.295779*ATAN3(BOD(3,1),BOD(1,1))
      ZRP=0.5*SQRT(BOD(2,1)**2+BOD(4,1)**2)
      ZIP=-57.295779*ATAN3(BOD(4,1),BOD(2,1))
      IF(ZIH.GT.90.) ZIH=ZIH-360.
      IF(ZIP.LT.-270.) ZIP=ZIP+360.
      EGH(JJ,N,MM)=CMPLX(ZRH,ZIH)
      ENP(JJ,N,MM)=CMPLX(ZRP,ZIP)
      IF(IOPT.EQ.3) EMK(JJ,N,MM)=2.*ZRP/WN(JJ,N,MM)
   30 CONTINUE
   20 CONTINUE
   10 CONTINUE
      RETURN
      END
```

```
      PROGRAM QPGM3
C
      COMMON/HP1/  NPAG,TITLE(8),PATT(7),RATIO
      COMMON/HP2/  ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/HP3/  NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X             AVBM(30),ST(30),IN(30),SQAR(30),X(30,20),Y(30,20)
      COMMON/HP4/  NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/HP5/  VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/HP6/  NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/HP7/  NFN,NFNS,FN(6),FNS(6)
      COMMON/HP8/  NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/HP9/  NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/HP10/ XZFO,XZVL,XZHB,XZPB,KV,KW
      COMMON/HP11/ CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/HP12/ CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/HP13/ GRAV,DEPCAT,SD(6),RBMST(10)
      COMMON/HP14/ EL,GCB,GYR,RGY,VCG,BRCL,RF33,RP35,RM55
      COMMON/HP15/ A33(30),A35(4,30),A53(4,30),A55(4,30),C35S,C55S,
     X             B33(4,30,3),B35(4,30,3),B53(4,30,3),B55(4,30,3)
      COMMON/HP16/ AHP(30),DHP(4,30),AP(30),DP(4,30)
      COMMON/HP17/ OMEGA,UN,PAH(19),PVH(19)
      COMMON/HP18/ BLOG(19,19),YLOG(19,19)
      COMMON/HP19/ KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/HP20/ II,EFH(4,30,3),EMP(4,30,3),EMK(4,30,3)
      COMPLEX II,EFH,EMP
C
C   END OF COMMON DECK
C      (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
      COMPLEX EGH,ENP
      COMMON/PR23/ EGH(4,30,3),ENP(4,30,3)
C
    1 FORMAT(1H0,5X,*MOTION AMPLITUDES AND PHASES*////
     X  6X,*THE HEAVE AMPLITUDE IS SCALED BY A.*//
     X  6X,*THE PITCH AMPLITUDE IS SCALED BY 2*,1H*,*A/L.*//
     X  6X,1H*,*PITCH DENOTES PITCH AMPLITUDE SCALED BY A*,1H*,
     X  *(WAVE NUMBER).*//
     X  6X,*A IS THE WAVE AMPLITUDE.*////
     X  6X,*FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT*,6H(G*L).//
     X  6X,*BETA IS THE WAVE HEADING ANGLE IN DEGREES.*/
     X  6X,*BETA = 180. FOR HEAD SEAS.*//
     X  6X,*OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED BY*,
     X  * SQRT(G/L).*//
     X  6X,*THE PHASE ANGLE IS MEASURED IN DEGREES WITH RESPECT TO THE *
     X  *WAVE AT THE CG. *//
     X  6X,*L/LAM IS L/(WAVE LENGTH).*//
     X  6X,*FOR FOLLOWING SEAS THE FREQUENCY DOMAIN IS DIVIDED INTO *,
     X  *THREE*/6X,*REGIONS SEPARATED BY TWO CRITICAL L/LAM DENOTED *,
     X  *CWR1 AND CWR2.*)
```

```
  5 FORMAT(1H1,14A6,18X,A6,I4/)
  8 FORMAT(1H0,5X,*MOTION AMPLITUDES AND PHASES*/6X,*FN = *,F5.3/
   X   6X,*BETA = *,F6.1/ 6X,*REGION*,I1,* CWR1 = *,F9.4,* CWR2 = *,
   X   F9.4//6X,*OMEGA*,5X,*L/LAM*,5X,*HEAVE*,5X,*PHASE*,5X,*PITCH*,
   X   5X,*PHASE*,4X,1H*,*PITCH*,5X,*LAM/L*)
  9 FORMAT(1H0,5X,*MOTION AMPLITUDES AND PHASES*/6X,*FN = *,F5.3/
   X   6X,*BETA = *,F6.1//6X,*OMEGA*,5X,*L/LAM*,5X,*HEAVE*,5X,*PHASE*,
   X   5X,*PITCH*,5X,*PHASE*,4X,1H*,*PITCH*,5X,*LAM/L*)
 10   FORMAT(F11.4,F10.4,F10.5,F10.3,F10.5,F10.3,F10.5,F10.4)
150   FORMAT(1H0,80X,23HHULL SEPARATION/BEAM = F7.4)
      IF(1.EQ.0) CALL PGM1B
      CON=AMP2/VOL
      CALL SOLVE(3,RF33,CON,1,NFN,1,NBTA,1,NFR)
      DO 20 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 20
      DO 30 N=1,LMT
      DO 30 MM=1,NBTA
      EFH(JJ,N,MM)=EGH(JJ,N,MM)
   30 EMP(JJ,N,MM)=ENP(JJ,N,MM)
   20 CONTINUE
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,150)RATIO
      WRITE(6,1)
      KR=0
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,150)RATIO
      DO 44 MM=1,NBTA
      DO 40 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 40
      LMP=LMT+4
      IF(KASE(JJ).NE.0) LMP=LMP+1
      IF(55-KR.GE.LMP) GO TO 43
      KR=0
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,150)RATIO
   43 IF(KASE(JJ).EQ.0) GO TO 41
      WRITE(6,8) FN(JJ),WANG(MM),KASE(JJ),CWR1(JJ),CWR2(JJ)
      GO TO 42
   41 WRITE(6,9) FN(JJ),WANG(MM)
   42 WRITE(6,10) (OMEN(N),SWR(JJ,N,MM),EFH(JJ,N,MM),EMP(JJ,N,MM),
     X   EMK(JJ,N,MM),RWS(JJ,N,MM),N=1,LMT)
      KR=KR+LMP
   40 CONTINUE
   44 CONTINUE
      CALL AERTRN
      END
```

```
      SUBROUTINE NILS(NOS,MS,ST,DS,JFK)
      DIMENSION ST(30),DS(30)
   81 FORMAT(1H0,5X,33HINCORRECT STATION SPACINGS - STOP)
    1 DO 5 K=1,NOS
    5 DS(K)=0.0
      NSM=NOS-2
      NSX=2*(NOS/2)
      IF(NSX.EQ.NOS) GO TO 11
      DO 10 K=1,NSM,2
      D1=ST(K+1)-ST(K)
      D2=ST(K+2)-ST(K+1)
      IF(ABS(D1-D2).GT.0.001) GO TO 777
      D=0.1*D2*0.16666667
      DS(K)=DS(K)+D
      DS(K+1)=DS(K+1)+4.0*D
      DS(K+2)=DS(K+2)+D
   10 CONTINUE
      GO TO 78
   11 IF((2*(MS/2)).EQ.MS) GO TO 12
      MS1=MS-2
      GO TO 13
   12 MS1=MS-1
   13 MS2=MS1+1
      MS3=MS2+1
      MS4=MS3+1
      IF((MS1.LT.3).OR.(MS4.GT.NSM)) GO TO 777
      MS0=MS1-2
      DO 20 K=1,MS0,2
      D1=ST(K+1)-ST(K)
      D2=ST(K+2)-ST(K+1)
      IF(ABS(D1-D2).GT.0.001) GO TO 777
      D=0.1*D2*0.16666667
      DS(K)=DS(K)+D
      DS(K+1)=DS(K+1)+4.0*D
      DS(K+2)=DS(K+2)+D
   20 CONTINUE
      D1=ST(MS2)-ST(MS1)
      D2=ST(MS3)-ST(MS2)
      D3=ST(MS4)-ST(MS3)
      IF((ABS(D1-D2).GT.0.001).OR.(ABS(D2-D3).GT.0.001)) GO TO 777
      D=0.15*D2*0.125
      DS(MS1)=DS(MS1)+D
      DS(MS2)=DS(MS2)+3.0*D
      DS(MS3)=DS(MS3)+3.0*D
      DS(MS4)=DS(MS4)+D
      DO 30 K=MS4,NSM,2
      D1=ST(K+1)-ST(K)
      D2=ST(K+2)-ST(K+1)
      IF(ABS(D1-D2).GT.0.001) GO TO 777
      D=0.1*D2*0.16666667
      DS(K)=DS(K)+D
      DS(K+1)=DS(K+1)+4.0*D
      DS(K+2)=DS(K+2)+D
   30 CONTINUE
   78 JFK=1
      GO TO 77
  777 JFK=0
      WRITE(6,81)
   77 RETURN
      END
```

```
      SUBROUTINE QDFCN
C
      COMMON/HP1/  NPAG,TITLE(8),PATT(7),RATIO
      COMMON/HP2/  ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/HP3/  NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X             AVBM(30),ST(30),IN(30),SQAR(30),X(30,20),Y(30,20)
      COMMON/HP4/  NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/HP5/  VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/HP6/  NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/HP7/  NFN,NFNS,FN(6),FNS(6)
      COMMON/HP8/  NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/HP9/  NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/HP10/ XZFO,XZVL,XZHB,XZPB,KV,KW
      COMMON/HP11/ CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/HP12/ CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/HP13/ GRAV,DEPCAT,SD(6),RBMST(10)
      COMMON/HP14/ EL,GCB,GYR,RGY,VCG,BRCL,RF33,RP35,RM55
      COMMON/HP15/ A33(30),A35(4,30),A53(4,30),A55(4,30),C35S,C55S,
     X             B33(4,30,3),B35(4,30,3),B53(4,30,3),B55(4,30,3)
      COMMON/HP16/ AHP(30),DHP(4,30),AP(30),DP(4,30)
      COMMON/HP17/ OMEGA,UN,PAH(19),PVH(19)
      COMMON/HP18/ BLOG(19,19),YLOG(19,19)
      COMMON/HP19/ KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/HP20/ II,EFH(4,30,3),EMP(4,30,3),EMK(4,30,3)
      COMPLEX II,EFH,EMP
C
C   END OF COMMON DECK
C      (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
      DO 10 JJ=1,NFN
      KASE(JJ)=KASE(1)
      MIL(JJ)=0
      CWR1(JJ)=0.0
      CWR2(JJ)=0.0
      DO 10 MM=1,NBTA
      DO 10 N=1,NFR
      WFR(JJ,N,MM)=0.
      WN(JJ,N,MM)=0.
   10 SWR(JJ,N,MM)=0.
      IF(JC.EQ.2) GO TO 2
      DO 20 JJ=1,NFN
      MIL(JJ)=NFR
      DO 20 MM=1,NBTA
      FNC=FN(JJ)*COSBET(MM)
      IF(ABS(FNC).LE.1.E-06) GO TO 31
      DO 30 N=1,NFR
      TAU=OMEN(N)*FNC
      WFR(JJ,N,MM)=.5*(1.-SQRT(1.-4.*TAU))/FNC
      WN(JJ,N,MM)=WFR(JJ,N,MM)*WFR(JJ,N,MM)
   30 SWR(JJ,N,MM)=WN(JJ,N,MM)/6.2831853
```

```
      GO TO 20
31    DO 35 N=1,NFR
      WFR(JJ,N,MM)=OMEN(N)
      WN(JJ,N,MM)=OMEN(N)*OMEN(N)
   35 SWR(JJ,N,MM)=WN(JJ,N,MM)/6.2831853
   20 CONTINUE
      GO TO 7
C
C   FOLLOWING SEA CALCULATIONS
C
 2    CONTINUE
      DO 40 MM=1,NBTA
      COSB=COSBET(MM)
      DO 40 JJ=1,NFN
      FNC=FN(JJ)*COSB
      CRT=.25/FNC
      CWR1(JJ)=2.0*CRT**2/3.1415927
      CWR2(JJ)=4.0*CWR1(JJ)
      DO 60 N=1,NFR
      IF(KASE(1).NE.3 .AND. OMEN(N).GT.CRT) GO TO 40
      MIL(JJ)=MIL(JJ)+1
      TAU=FNC*OMEN(N)
      IF(KASE(1).EQ.1) WFR(JJ,N,MM)=.5*(1.+SQRT(1.-4.*TAU))/FNC
      IF(KASE(1).EQ.2) WFR(JJ,N,MM)=.5*(1.-SQRT(1.-4.*TAU))/FNC
      IF(KASE(1).EQ.3) WFR(JJ,N,MM)=.5*(1.+SQRT(1.+4.*TAU))/FNC
      WN(JJ,N,MM)=WFR(JJ,N,MM)*WFR(JJ,N,MM)
      SWR(JJ,N,MM)=WN(JJ,N,MM)/6.2831853
60    CONTINUE
40    CONTINUE
7     RETURN
      END
```

```
      SUBROUTINE FRANK
C
      COMMON/HP1/  NPAG,TITLE(8),PATT(7),RATIO
      COMMON/HP2/  ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/HP3/  NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X             AVBM(30),ST(30),IN(30),SQAR(30),X(30,20),Y(30,20)
      COMMON/HP4/  NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/HP5/  VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/HP6/  NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/HP7/  NFN,NFNS,FN(6),FNS(6)
      COMMON/HP8/  NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/HP9/  NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/HP10/ XZFO,XZVL,XZHB,XZPB,KV,KW
      COMMON/HP11/ CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/HP12/ CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/HP13/ GRAV,DEPCAT,SD(6),RBMST(10)
      COMMON/HP14/ EL,GCB,GYR,RGY,VCG,BRCL,RF33,RP35,RM55
      COMMON/HP15/ A33(30),A35(4,30),A53(4,30),A55(4,30),C35S,C55S,
     X             B33(4,30,3),B35(4,30,3),B53(4,30,3),B55(4,30,3)
      COMMON/HP16/ AHP(30),DHP(4,30),AP(30),DP(4,30)
      COMMON/HP17/ OMEGA,UN,PAH(19),PVH(19)
      COMMON/HP18/ BLOG(19,19),YLOG(19,19)
      COMMON/HP19/ KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/HP20/ II,EFH(4,30,3),EMP(4,30,3),EMK(4,30,3)
      COMPLEX II,EFH,EMP
C
C    END OF COMMON DECK
C       (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
      COMPLEX CEXH(4,30,3),CEXM(4,30,3),EKXCD,EKZDY,F35,G35,IDW,P3,XU
    9 FORMAT(1H0,5X,31HMATRIX IS SINGULAR FOR OMEGA = F7.4)
      XIP2=XIP*XIP
      CMONO=1.
      IF(MONO.EQ.2) CMONO=2.
      SAREA=AREA(K)*BEAM(K)*DRFT(K)
      IF(BEAM(K) .LE. 1.E-08) SAREA=AREA(K)*DRFT(K)**2
      IF(MPS(K).NE.1) CALL FINIT
      DO 10 N=1,NFR
      OMEGA=OMEN(N)
      UN=OMEGA*OMEGA
      IDW=II/OMEGA
      IF(MPS(K).NE.1) GO TO 12
      DHHA=EMK(1,N,1)
      DHHB=EMK(2,N,1)
      GO TO 17
   12 CALL PRESS
      IF(ID.EQ.1) GO TO 11
      WRITE(6,9) OMEGA
      GO TO 77
```

```
11 DHHA=0.0
   DHHB=0.0
   DO 20 I=1,NON
   CON=CMONO*DEL(I)*CSE(I)
   DHHA=DHHA+CON*PAH(I)
20 DHHB=DHHB+CON*PVH(I)
   IF(MPS(K) .NE. 2) GO TO 17
   EMK(1,N,1)=DHHA
   EMK(2,N,1)=DHHB
17 DHPA=-XIP*DHHA
   DHPB=-XIP*DHHB
   DPPA=XIP2*DHHA
   DPPB=XIP2*DHHB
   A33(N)=A33(N) +DST*DHHA
   AHP(N)=AHP(N)+DST*DHPA
   AP(N)=AP(N)+DST*DPPA
   DO 30 JJ=1,NFN
   XU=-XIP-IDW*FN(JJ)
   CONST=0.
   CONSA=0.
   IF(K.GE.KV .AND. K.LE.KW) GO TO 90
   CONST=UN*SAREA*XZHB*FN(JJ)*CMONO
   CONSA = XZPB * CONST
90 B33(JJ,N,1)=B33(JJ,N,1)+DST*(DHHB+CONST)
   DP(JJ,N)=DP(JJ,N)+DST*(DPPB+CONSA*XIP2)
   DHP(JJ,N)=DHP(JJ,N)+DST*(DHPB-XIP*CONST)
89 IF (MIL(JJ).LT.N) GO TO 30
   DO 33 MM=1,NBTA
   COSB=COSBET(MM)
   SINB=SINBET(MM)
   WNT=WFR(JJ,N,MM)
   WNO=WN(JJ,N,MM)
   EKXCD=CEXP(II*WNO*XIP*COSB)*DST*CMONO
   IF(MPS(K).NE.1) GO TO 42
   F35=CEXH(JJ,N,MM)
   G35=CEXM(JJ,N,MM)
   GO TO 160
42 F35=(0.,0.)
   G35=(0.,0.)
   IF(MONO.NE.1) GO TO 32
   DO 41 I=1,NON
   EKZDY=CEXP(WNO*(YY(I)-II*XX(I)*SINB))*DEL(I)
   ETA2S=-SNE(I)*SINB
   P3=CMPLX(PAH(I),PVH(I))
   CSEI=CSE(I)
   F35=F35+CSEI*EKZDY
   G35=G35+P3*(ETA2S+II*CSEI)*EKZDY
41 CONTINUE
   G35=II*WNT/OMEGA*G35
   GO TO 18
32 DO 31 I=1,NON
   EKZD=EXP(WNO*YY(I))*DEL(I)
   CAYYS=WNO*XX(I)*SINB
   CCOSK=CSE(I)*COS(CAYYS)
```

```
      SINKYS=SIN(CAYYS)
C   NOTE-- ETA2=-SNE(I),    ETA3=CSE(I)
      ETA2S=-SNE(I)*SINB
      P3=CMPLX(PAH(I),PVH(I))
      F35=F35+CCOSK*EKZD
      G35=G35+(-CCOSK+ETA2S*SINKYS)*EKZD*P3
   31 CONTINUE
      G35=WNT/OMEGA*G35
   18 IF(MPS(K).NE.2) GO TO 160
      CEXH(JJ,N,MM)=F35
      CEXM(JJ,N,MM)=G35
  160 EFH(JJ,N,MM)=EFH(JJ,N,MM)+EKXCD*(F35+G35)
      EMP(JJ,N,MM)=EMP(JJ,N,MM)+EKXCD*(-XIP*F35+XU*G35)
   33 CONTINUE
   30 CONTINUE
   10 CONTINUE
   77 RETURN
      END
```

```
      SUBROUTINE FINIT
      COMMON/HP2/  ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/HP4/  NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/HP18/ BLOG(19,19),YLOG(19,19)
      DIMENSION X(20),Y(20)
      EQUIVALENCE (XS,X),(YS,Y)
      PI=3.1415927
      DPNL=0.
      DCNL=0.
      PPL=0.
      PCL=0.
      DO 10 I=1,NON
      XM1=XX(I)-X(1)
      YM1=YY(I)-Y(1)
      YP1=YY(I)+Y(1)
      FPR1=.5*ALOG(XM1**2+YM1**2)
      FCR1=.5*ALOG(XM1**2+YP1**2)
      APR1=ATAN2(YM1,XM1)
      ACR1=ATAN2(YP1,XM1)
      IF(I .GE. MAXD) GO TO 30
      IF(YM1 .LT.0.) APR1=APR1+2.*PI
      IF(YP1.GE. 0.) ACR1=-PI
   30 CONTINUE
      IF(MONO .EQ. 1) GO TO 35
      XP1=XX(I)+X(1)
      FPL1=.5*ALOG(XP1**2+YM1**2)
      FCL1=.5*ALOG(XP1**2+YP1**2)
      APL1=ATAN2(YM1,XP1)
      ACL1=ATAN2(YP1,XP1)
   35 CONTINUE
      DO 10 J=1,NON
      XM2=XX(I)-X(J+1)
      YM2=YY(I)-Y(J+1)
      YP2=YY(I)+Y(J+1)
      FPR2=.5*ALOG(XM2**2+YM2**2)
      FCR2=.5*ALOG(XM2**2+YP2**2)
      APR2=ATAN2(YM2,XM2)
      IF(I .GE. MAXD) GO TO 20
      J11=J+1
      IF(I .GE. J11 .AND. APR2 .LE. 0.) APR2=APR2+2.*PI
      IF(J11 .GT. MAXD .AND. APR2 .LT. 0.) APR2=APR2+2.*PI
      IZIP=(APR1-APR2)*10000.0
      ZIP=IZIP
      ZIP=ZIP/10000.0
      IF(ZIP .GT. PI) APR1=APR1-2.*PI
      IF(XM2 .GT. 0.) GO TO 4
      GO TO 5
   20 J1=J+1
      IF(XM2 .GT. 0.) GO TO 4
      IF(J1 .GT. I) GO TO 6
C    **** CARDS BELOW ARE FOR CONVEX OR CONCAVE TOP DECK ***
      IF(YM2 .LT. 0.) APR2=APR2+2.*PI
```

```
      GO TO 5
C **** CARDS BELOW ARE FOR CONVEX,FLAT OR CONCAVE BOTTOM ***
    6 IF(YM2 .GE. 0.) APR2=APR2-2.*PI
    5 IF(YP2 .LT. 0.) GO TO 4
      ACR2=-PI
      GO TO 3
    4 ACR2=ATAN2(YP2,XM2)
    3 SIMJ=SNE(I)*CSE(J)-SNE(J)*CSE(I)
      CIMJ=CSE(I)*CSE(J)+SNE(I)*SNE(J)
      SIPJ=SNE(I)*CSE(J)+SNE(J)*CSE(I)
      CIPJ=CSE(I)*CSE(J)-SNE(I)*SNE(J)
      DPNR=SIMJ*(FPR1-FPR2)+CIMJ*(APR1-APR2)
      PPR=CSE(J)*(XM1*FPR1-YM1*APR1-XM1-XM2*FPR2+YM2*APR2+XM2)+SNE(J)*(Y
     1M1*FPR1+XM1*APR1-YM1-YM2*FPR2-XM2*APR2+YM2)
      DCNR=SIPJ*(FCR1-FCR2)+CIPJ*(ACR1-ACR2)
      PCR=CSE(J)*(XM1*FCR1-YP1*ACR1-XM1-XM2*FCR2+YP2*ACR2+XM2)+SNE(J)*(Y
     1P2*FCR2+XM2*ACR2+YP1-YP1*FCR1-XM1*ACR1-YP2)
      IF(MONO .EQ. 1) GO TO 37
      XP2=XX(I)+X(J+1)
      FPL2=.5*ALOG(XP2**2+YM2**2)
      FCL2=.5*ALOG(XP2**2+YP2**2)
      APL2=ATAN2(YM2,XP2)
      ACL2=ATAN2(YP2,XP2)
      DPNL=SIPJ*(FPL2-FPL1)+CIPJ*(APL2-APL1)
      PPL=CSE(J)*(XP2*FPL2-YM2*APL2-XP2-XP1*FPL1+YM1*APL1+XP1)+SNE(J)*(Y
     1M1*FPL1+XP1*APL1+YM2-YM2*FPL2-XP2*APL2-YM1)
      DCNL=SIMJ*(FCL2-FCL1)+CIMJ*(ACL2-ACL1)
      PCL=CSE(J)*(XP2*FCL2-YP2*ACL2-XP2-XP1*FCL1+YP1*ACL1+XP1)+SNE(J)*(Y
     1P2*FCL2+XP2*ACL2-YP2-YP1*FCL1-XP1*ACL1+YP1)
   37 CONTINUE
      BLOG(I,J)=DPNR+DPNL-DCNR-DCNL
      YLOG(I,J)=PPR+PPL-PCR-PCL
      IF(J.EQ.NON) GO TO 10
      XM1=XM2
      YM1=YM2
      FPR1=FPR2
      FCR1=FCR2
C    **** NEXT CARD HANDLES ANGLE DIFFERENCE ACROSS MAXD POINT ****
      IF(I .LT. MAXD .AND. (J+1).EQ. MAXD .AND. APR2 .LT. 0.) APR2=APR2
     1+ 2.*PI
      APR1=APR2
      ACR1=ACR2
      YP1=YP2
      IF(MONO .EQ. 1) GO TO 10
      XP1=XP2
      FPL1=FPL2
      FCL1=FCL2
      APL1=APL2
      ACL1=ACL2
   10 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE PRESS
      COMMON/HP2/  ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/HP4/  NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/HP17/ OMEGA,UN,PAH(19),PVH(19)
      COMMON/HP18/ BLOG(19,19),YLOG(19,19)
      DIMENSION CON(38,1),CT(38,38),SOUR(19,19),WAVE(19,19)
      DIMENSION INDEX(38,3)
      DIMENSION X(20),Y(20)
      EQUIVALENCE (XS,X),(YS,Y)
      DPL=0.
      PPL=0.
      DWL=0.
      PWL=0.
      DO 10 I=1,NON
      NI=NON+I
      CON(I,1)=0.0
      CON(NI,1)=OMEGA*CSE(I)
   22 XR1=UN*(XX(I)-X(1))
      YR1=-UN*(YY(I)+Y(1))
      CALL DAVID(XR1,YR1,EJ1,CXR1,SXR1,RAR1,RBR1,CR1,SR1)
      IF(MONO .EQ. 1) GO TO 37
      XL1=UN*(XX(I)+X(1))
      YL1=YR1
      CALL DAVID(XL1,YL1,EJ1,CXL1,SXL1,RAL1,RBL1,CL1,SL1)
   37 CONTINUE
      DO 10 J=1,NON
      NJ=NON+J
      SIPJ=SNE(I)*CSE(J)+SNE(J)*CSE(I)
      CIPJ=CSE(I)*CSE(J)-SNE(I)*SNE(J)
      XR2=UN*(XX(I)-X(J+1))
      YR2=-UN*(YY(I)+Y(J+1))
      CALL DAVID(XR2,YR2,EJ2,CXR2,SXR2,RAR2,RBR2,CR2,SR2)
      DPR=2.*(SIPJ*(CR1-CR2)-CIPJ*(SR1-SR2))
      PPR=2./UN*(SNE(J)*(RAR1-RAR2)+CSE(J)*(RBR1-RBR2))
      DWR=6.2831853*(EJ2*(SXR2*CIPJ-CXR2*SIPJ)-EJ1*(SXR1*CIPJ-CXR1*SIPJ)
     1)
      PWR=6.2831853/UN*(EJ1*(SXR1*CSE(J)-CXR1*SNE(J))-EJ2*(SXR2*CSE(J)-
     1CXR2*SNE(J)))
      IF(MONO .EQ. 1) GO TO 38
      SIMJ=SNE(I)*CSE(J)-SNE(J)*CSE(I)
      CIMJ=CSE(I)*CSE(J)+SNE(I)*SNE(J)
      XL2=UN*(XX(I)+X(J+1))
      YL2=YR2
      CALL DAVID(XL2,YL2,EJ2,CXL2,SXL2,RAL2,RBL2,CL2,SL2)
      DPL=2.*(CIMJ*(SL1-SL2)-SIMJ*(CL1-CL2))
      PPL=2./UN*(SNE(J)*(RAL1-RAL2)+CSE(J)*(RBL2-RBL1))
      DWL=6.2831853*(EJ1*(SXL1*CIMJ-CXL1*SIMJ)-EJ2*(SXL2*CIMJ-CXL2*SIMJ)
     1)
      PWL=6.2831853/UN*(EJ2*(SXL2*CSE(J)+CXL2*SNE(J))-EJ1*(SXL1*CSE(J)+
     1CXL1*SNE(J)))
   38 CONTINUE
```

```
      CT(I,J)=BLOG(I,J)+DPR+DPL
      CT(NI,NJ)=CT(I,J)
      CT(I,NJ)=DWR+DWL
      CT(NI,J)=-CT(I,NJ)
      SOUR(I,J)=YLOG(I,J)+PPR+PPL
      WAVE(I,J)=PWR+PWL
      IF(J.EQ.NON) GO TO 10
      XR1=XR2
      YR1=YR2
      EJ1=EJ2
      CR1=CR2
      SR1=SR2
      RAR1=RAR2
      RBR1=RBR2
      CXR1=CXR2
      SXR1=SXR2
      IF(MONO .EQ. 1) GO TO 10
      XL1=XL2
      YL1=YL2
      CL1=CL2
      SL1=SL2
      RAL1=RAL2
      RBL1=RBL2
      CXL1=CXL2
      SXL1=SXL2
   10 CONTINUE
      CALL MATINS(CT,38,NOE,CON,1,1,DTRM,ID,INDEX)
      GOTO(11,77),ID
   11 DO 20 I=1,NON
      PAH(I)=0.0
      PVH(I)=0.0
      DO 30 J=1,NON
      NJ=NON+J
      PAH(I)=PAH(I)+CON(J,1)*WAVE(I,J)-CON(NJ,1)*SOUR(I,J)
   30 PVH(I)=PVH(I)+CON(J,1)*SOUR(I,J)+CON(NJ,1)*WAVE(I,J)
      PAH(I)=OMEGA*PAH(I)
   20 PVH(I)=OMEGA*PVH(I)
   77 RETURN
      END
```

```
      SUBROUTINE DAVID(X,Y,E,C,S,RA,RB,CIN,SUN)
C     DAVID - COMPUTATION OF FREQUENCY DEPENDENT PARTS OF
C     2-D POTENTIALS AND KERNELS
      DIMENSION F(5),D(5)
      DATA (F(I),I=1,5)/0.52175561,0.39866681,0.07594245,
     1      0.003611758,0.000023369972/
      DATA (D(I),I=1,5)/0.26356032,1.4134031,3.5964258,
     1      7.08581,12.640801/
      Q=3.1415927
      AT=ATAN2(X,Y)
      ARG=AT-0.5*Q
      E=EXP(-Y)
      C=COS(X)
      S=SIN(X)
      R=X**2+Y**2
      AL=0.5*ALOG(R)
      A=-Y
      B=-X
      IF(A.GE.0.0) GO TO 78
      IF(B.EQ.0.0) GO TO 79
   78 IF(R.GE.100.) GO TO 10
   79 TEST=0.00001
      IF(R.LT.1.0) GO TO 5
      TEST=0.1*TEST
      IF(R.LT.2.0) GO TO 5
      TEST=0.1*TEST
      IF(R.LT.4.0) GO TO 5
      TEST=0.1*TEST
    5 CONTINUE
      SUMC=0.57721566+AL+Y
      SUMS=AT+X
      TC=Y
      TS=X
      DO 1 K=1,500
      TO=TC
      COX=K
      CAY=K+1
      FACT=COX/CAY**2
      TC=FACT*(Y*TC-X*TS)
      TS=FACT*(Y*TS+X*TO)
      SUMC=SUMC+TC
      SUMS=SUMS+TS
      IF(K.GE.500) GO TO 3
      IF((ABS(TC)+ABS(TS)).GT.TEST) GO TO 1
    3 CIN=E*(C*SUMC+S*SUMS)
      SUN=E*(S*SUMC-C*SUMS)
      GO TO 4
    1 CONTINUE
   10 G1=0.
      G2=0.
      DO 20 I=1,5
      DEN=(-Y+D(I))**2+X**2
      GA=F(I)*(-Y+D(I))/DEN
      GB=F(I)*(-X)/DEN
```

```
      G1=G1+GA
   20 G2=G2+GB
      CIN=E*Q*S-G1
      SUN=-(E*Q*S+G2)
    4 RA=AL-CIN
      RB=ARG+SON
      RETURN
      END
```

```
      FUNCTION ATAN3(Y,X)
C     ATN3 - MODIFICATION OF ATAN2, SETS ATAN2(0.,0.)=0.
      IF(Y)1,2,1
    2 IF(X)1,3,1
    3 ATAN3=0.0
      GO TO 4
    1 ATAN3=ATAN2(Y,X)
    4 RETURN
      END
```

```
      SUBROUTINE MATINS(A,NR,N1,B,NC,M1,DETERM,ID,INDEX)
C     MATRIX INVERSION WITH ACCOMPANYING SOLUTION OF LINEAR EQUATIONS
C     PIVOT METHOD
C     FORTRAN IV SINGLE PRECISION WITH ADJUSTABLE DIMENSION
C     FEBRUARY 1966   S GOOD  DAVID TAYLOR MODEL BASIN   AM MAT4
C          WHERE CALLING PROGRAM MUST INCLUDE
C              DIMENSION A(NR,NR), B(NR,NC), INDEX(NR,3)
C           N      IS THE ORDER OF A
C           M      IS THE NUMBER OF COLUMN VECTORS IN B(MAY BE 0)
C          DETERM WILL CONTAIN DETERMINANT ON EXIT
C           ID     WILL BE SET BY ROUTINE TO 2 IF MATRIX A IS SINGULAR
C                  1 IF INVERSION WAS SUCCESSFUL
C           A      THE INPUT MATRIX WILL BE REPLACED BY A INVERSEE
C           B      THE COLUMN VECTORS WILL BE REPLACED BY CORRESPONDING
C                  SOLUTION VECTORS
C           INDEX  WORKING STORAGE ARRAY
C          IF IT IS DESIRED TO SCALE THE DETERMINANT CARD      MAY BE
C          DELETED AND DETERM PRESET BEFORE ENTERING THE ROUTINE
C
      EQUIVALENCE (IROW,JROW), (ICOLUM,JCOLUM), (AMAX, T, SWAP)
                             DIMENSION  A(NR,NR),  B(NR,NC),  INDEX(NR,3)
C
C      INITIALIZATION
C
       N=N1
      M=M1
      DETERM=1.
       DO 20 J=1,N
   20 INDEX(J,3) = 0
       DO 550 I=1,N
C
C     SEARCH FOR PIVOT ELEMENT
C
      AMAX = 0.0
      DO 105 J=1,N
      IF(INDEX(J,3)-1) 60, 105, 60
   60 DO 100 K=1,N
      IF(INDEX(K,3)-1) 80, 100, 715
   80 IF (      AMAX -ABS (A(J,K))) 85, 100, 100
   85 IROW=J
      ICOLUM =K
      AMAX = ABS (A(J,K))
  100 CONTINUE
  105 CONTINUE
      INDEX(ICOLUM,3) = INDEX(ICOLUM,3) +1
      INDEX(I,1)=IROW
      INDEX(I,2)=ICOLUM
C
C     INTERCHANGE ROWS TO PUT PIVOT ELEMENT ON DIAGONAL
C
      IF (IROW-ICOLUM) 140, 310, 140
  140 DETERM=-DETERM
      DO 200 L=1,N
      SWAP=A(IROW,L)
```

```
      A(IROW,L)=A(ICOLUM,L)
  200 A(ICOLUM,L)=SWAP
      IF(M) 310, 310, 210
  210 DO 250 L=1, M
      SWAP=B(IROW,L)
      B(IROW,L)=B(ICOLUM,L)
  250 B(ICOLUM,L)=SWAP
C
C     DIVIDE PIVOT ROW BY PIVOT ELEMENT
C
  310 PIVOT   =A(ICOLUM,ICOLUM)
      DETERM=DETERM*PIVOT
  330 A(ICOLUM,ICOLUM)=1.0
      DO 350 L=1,N
  350 A(ICOLUM,L)=A(ICOLUM,L)/PIVOT
      IF(M) 380, 380, 360
  360 DO 370 L=1,M
  370 B(ICOLUM,L)=B(ICOLUM,L)/PIVOT
C
C     REDUCE NON-PIVOT ROWS
C
  380 DO 550 L1=1,N
      IF(L1-ICOLUM) 400, 550, 400
  400 T=A(L1,ICOLUM)
      A(L1,ICOLUM)=0.0
      DO 450 L=1,N
  450 A(L1,L)=A(L1,L)-A(ICOLUM,L)*T
      IF(M) 550, 550, 460
  460 DO 500 L=1,M
  500 B(L1,L)=B(L1,L)-B(ICOLUM,L)*T
  550 CONTINUE
C
C     INTERCHANGE COLUMNS
C
      DO 710 I=1,N
      L=N+1-I
      IF (INDEX(L,1)-INDEX(L,2)) 630, 710, 630
  630 JROW=INDEX(L,1)
      JCOLUM=INDEX(L,2)
      DO 705 K=1,N
      SWAP=A(K,JROW)
      A(K,JROW)=A(K,JCOLUM)
      A(K,JCOLUM)=SWAP
  705 CONTINUE
  710 CONTINUE
      DO 730 K = 1,N
      IF(INDEX(K,3) -1) 715,720,715
 720   CONTINUE
 730   CONTINUE
       ID = 1
 810  RETURN
 715  ID = 2
       GO TO 810
       END
```

```
      OVERLAY(4,0)
      PROGRAM PGM4
C
      COMMON/HP1/  NPAG,TITLE(8),PATT(7),RATIO
      COMMON/HP2/  ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/HP3/  NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X             AVBM(30),ST(30),IN(30),SQAR(30),X(30,20),Y(30,20)
      COMMON/HP4/  NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/HP5/  VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/HP6/  NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/HP7/  NFN,NFNS,FN(6),FNS(6)
      COMMON/HP8/  NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/HP9/  NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/HP10/ XZFO,XZVL,XZHB,XZPB,KV,KW
      COMMON/HP11/ CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/HP12/ CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/HP13/ GRAV,DEPCAT,SD(6),RBMST(10)
      COMMON/HP14/ EL,GCB,GYR,RGY,VCG,BRCL,RF33,RP35,RM55
      COMMON/HP15/ A33(30),A35(4,30),A53(4,30),A55(4,30),C35S,C55S,
     X             B33(4,30,3),B35(4,30,3),B53(4,30,3),B55(4,30,3)
      COMMON/HP16/ AHP(30),DHP(4,30),AP(30),DP(4,30)
      COMMON/HP17/ OMEGA,UN,PAH(19),PVH(19)
      COMMON/HP18/ BLOG(19,19),YLOG(19,19)
      COMMON/HP19/ KASE(4),MIL(4),CWR1(4),CWR2(4),WFP(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/HP20/ II,EFH(4,30,3),EMP(4,30,3),EMK(4,30,3)
      COMPLEX II,EFH,EMP
C
C   END OF COMMON DECK
C      (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
      DIMENSION LLT(2),LUT(2),XL(50),YL(50),TITL(8)
      DIMENSION BX(30)
    1 FORMAT(I9,F9.4)
      IF(LP.LE.0 .AND. IP.LE.0) GO TO 77
      IF(ISTART.GT.0) GO TO 9
      ISTART=1
      OMAX=OWAX
      READ(5,1004) NAME1,NAME2,NAME3
 1004 FORMAT(3A10)
      CALL CAMRAV(35)
      CALL IDFRMV(NAME1,NAME2,NAME3)
    9 ENCODE(48,8,TITL) TITLE
    8 FORMAT(8A6)
      CALL FRAMEV(3)
      MRK1=63
      MRK2=38
      IF(LP.LE.0) GO TO 77
      DO 100 JIC=1,NOS
      NUT=NM(JIC)
```

```
      BX(JIC) = 0.
      IF (NUT .LE. 0) GO TO 100
      DO 101 KIC=1,NUT
101   XL(KIC)=X(JIC,KIC)
      XSM=XMIN(NUT,XL)
      XLG=XMAX(NUT,XL)
      BX(JIC)=XLG-XSM
      BX(JIC)=ABS(BX(JIC))
 100  CONTINUE
      HAM=XMAX(NOS,BX)
      DTM=XMAX(NOS,DRFT)
      RG=1.2*AMAX1(HAM,DTM)
      LLT(1)=1
      LLT(2)=MS
      LUT(1)=MS
      LUT(2)=NOS
      XB=0.
      XT=RG
      DO 5 LL=1,2
      LTL=LLT(LL)
      LTU=LUT(LL)
    4 CALL GRID1V(3,XB,XT,-RG,0.,RG,RG,-0,-0,0,0,1,1)
      CALL PRINTV(48,TITL,320,1014)
      IF(LL.GT.1) GO TO 6
      CALL PRINTV(-16,16HFORWARD STATIONS,445,9)
      GO TO 7
    6 CALL PRINTV(-12,12HAFT STATIONS,465,9)
    7 DO 10 K=LTL,LTU
      IF(BEAM(K).LT.0.) GO TO 10
      IF(NM(K).GE.0) GO TO 11
      HBM=0.5*BEAM(K)
      SUR=AREA(K)
      TAR=DRFT(K)/HBM
      B=3.*(1.+TAR)
      C=1.+TAR*(10.-10.185916*SUR+TAR)
      AFLA=0.5*(B-SQRT(C))
      AX=2.*(AFLA-TAR)-1.
      BZ=2.*(1.+TAR-AFLA)
      AY=2.*AFLA-TAR-2.
      BY=BZ
      ARG=0.
      XL(1)=0.
      YL(1)=-DRFT(K)
      DO 12 J=2,20
      ARG=ARG+0.078539817
      SE1=SIN(ARG)
      CE1=-COS(ARG)
      SE2=SE1*SE1
      CE2=CE1*CE1
      XL(J)=SE1*(AX+BZ*SE2)*HBM
      YL(J)=CE1*(AY+BY*CE2)*HBM
      IF(YL(J).LT.0.0) GO TO 12
      YL(J)=0.0
   12 CONTINUE
```

```
      XL(21)=HBM
      YL(21)=0.
      IF(LL.EQ.1) GO TO 3
      DO 2 J=1,21
    2 XL(J)=-XL(J)
    3 DO 13 J=1,20
   13 CALL DOTLNV(NXV(XL(J)),NYV(YL(J)),NXV(XL(J+1)),NYV(YL(J+1)))
      CALL APLOTV(21,XL,YL,1,1,1,MRK2,IERR)
      GO TO 10
   11 NUT=NM(K)
       IF (NUT .EQ. 0) GO TO 10
      NON=NUT-1
      SIGN=1.
      IF(LL.EQ.2) SIGN=-1.
      HRG=.5*RG
      DO 14 J=1,NUT
      XL(J)=SIGN*X(K,J)+HRG
   14 YL(J)=Y(K,J)
      DO 15 J=1,NON
   15 CALL LINEV(NXV(XL(J)),NYV(YL(J)),NXV(XL(J+1)),NYV(YL(J+1)))
      CALL APLOTV(NUT,XL,YL,1,1,1,MRK1,IERR)
   10 CONTINUE
    5 CONTINUE
  777 CALL FRAMEV(3)
       CALL PLTND (0)
77    CONTINUE
      CALL AETSKC(5LMOT35)
      END
```

```
      OVERLAY(5,0)
      PROGRAM PGM5
C
      COMMON/HP1/   NPAG,TITLE(8),PATT(7),RATIO
      COMMON/HP2/   ID,IG,IP,IND,ISO,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X              NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/HP3/   NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X              AVBM(30),ST(30),IN(30),SQAR(30),X(30,20),Y(30,20)
      COMMON/HP4/   NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X              SNE(19),CSE(19)
      COMMON/HP5/   VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/HP6/   NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/HP7/   NFN,NFNS,FN(6),FNS(6)
      COMMON/HP8/   NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/HP9/   NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/HP10/  XZFO,XZVL,XZHB,XZPB,KV,KW
      COMMON/HP11/  CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/HP12/  CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/HP13/  GRAV,DEPCAT,SD(6),RBMST(10)
      COMMON/HP14/  EL,GCB,GYR,RGY,VCG,BRCL,RF33,RP35,RM55
      COMMON/HP15/  A33(30),A35(4,30),A53(4,30),A55(4,30),C35S,C55S,
     X              B33(4,30,3),B35(4,30,3),B53(4,30,3),B55(4,30,3)
      COMMON/HP16/  AHP(30),DHP(4,30),AP(30),DP(4,30)
      COMMON/HP17/  OMEGA,UN,PAH(19),PVH(19)
      COMMON/HP18/  BLOG(19,19),YLOG(19,19)
      COMMON/HP19/  KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X              WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/HP20/  II,EFH(4,30,3),EMP(4,30,3),EMK(4,30,3)
      COMPLEX II,EFH,EMP
C
C    END OF COMMON DECK
C       (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
      DIMENSION SWH(5)
      EQUIVALENCE (SWH,WINK)
      DIMENSION WORT(2),STA(23),OMENC(51),OWAVE(51),WAVEN(51),ELOLA(51),
     1OMEN2(51),HEAVE(51),PITCH(51),SSPEC(51),DELTA(51),EPSIL(51),HEAV2(
     251),PITC2(51),ABMO(51),HSPEC(51),PSPEC(51),ADSP(51),AVSP(51),ACSP(
     351),RDSP(51), RVSP(51),RASP(51),OWAK(5),OMAK(5),ORES(5),ORESV(5),
     4ORESA(5),FITCH(51)
      DIMENSION SPROB(23), SNUM(23), RVELS(23), RMOTS(23)
      DIMENSION ABMOL(51,20), RDSPL(51,20)
       DATA WORT /6H ABS. ,6H REL. /
    1 FORMAT(6X,25HOUTPUT FOR IRREGULAR SEAS)
2     FORMAT(1H0,5X,20HWAVE HEIGHTS IN FEET/6X,14HSIGNIFICANT = F6.2,5X,
     110HAVERAGE = F6.2,5X,25H1/10TH HIGHEST AVERAGE = F6.2//6X,12HSEA S
     2TATE = I1//6X,23HWAVE PERIODS IN SECONDS/6X,23HSIGNIFICANT RANGE F
     3ROM F6.2,4H TO F6.2,5X,22HPER. OF MAX. ENERGY = F6.2,5X,10HAVERAGE
     4 = F6.2//6X,22HAVERAGE WAVE LENGTH = F7.2,5H FEET//6X,99HTHE WAVE
     5HEIGHTS, AVERAGE WAVE LENGTH AND PERIODS ARE COMPUTED FROM THE PIE
     6RSON-MOSKOWITZ SPECTRUM.)
3     FORMAT(6X,26HSIGNIFICANT WAVE HEIGHT = F6.2,4H FT.,5X,14HSHIP LENG
     1TH = F7.2,4H FT.,5X,13HSHIP SPEED = F5.2,6H KNOTS,5X,13HFROUDE NO.
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      2 = F5.3)
    4 FORMAT(1H0,8X,10HENC. FREQ.,8X,10HWAVE FREQ.,10X,8HL/LAMBDA,6X,12H
     1SEA SPECTRUM,4X,14HHEAVE SPECTRUM,4X,14HPITCH SPECTRUM/11X,8HPER S
     2EC.,10X,8HPER SEC.,22X,14HIN SEC.*FT.**2,4X,14HIN SEC.*FT.**2,4X,1
     34HIN SEC.*FT.**2)
    5 FORMAT(1H1,14A6,18X,A6,I4/)
    6 FORMAT(1X,6F18.6)
7     FORMAT(1H0,5X,15HPITCH RESPONSES)
8     FORMAT(16X,32HDISPLACEMENT IN FEET AND DEGREES,2X,34HVELOCITY IN F
     1T. AND DEGS. PER SEC.,3X,33HACC. IN FT. AND DEGS. PER SEC.**2)
    9 FORMAT(18X,30H AVERAGE   SIGNIF. 1/10TH H.A.,6X,30H AVERAGE   SIGN
     1IF. 1/10TH H.A.,6X,30H AVERAGE   SIGNIF. 1/10TH H.A.)
10    FORMAT(3X,13HAS BOW MOTION,2X,3(3F10.3,6X))
   11 FORMAT(1H0,5X,48HABSOLUTE AND RELATIVE VERTICAL MOTION ALONG SHIP)
   12 FORMAT(20X,29HVERTICAL DISPLACEMENT IN FEET,14X,22HVERT. VEL. IN F
     1T./SEC.,9X,27HVERT. ACC. IN FT./SEC./SEC.)
   13 FORMAT(6X,6H STAT.,6X,30H AVERAGE   SIGNIF. 1/10TH H.A.,6X,30H AVE
     1RAGE   SIGNIF. 1/10TH H.A.,6X,30H AVERAGE   SIGNIF. 1/10TH H.A.)
14    FORMAT(6X,F6.2,A6,3(3F10.3,6X))
16    FORMAT(3X,13HANGULAR PITCH,2X,3(3F10.3,6X))
17    FORMAT(1H0,5X,47HSTATISTICAL DESCRIPTION OF FULLY DEVELOPED SEAS)
18    FORMAT(18X,28HINSUFFICIENT FREQUENCY RANGE)
19    FORMAT(6X,F6.2,A6,6X,28HINSUFFICIENT FREQUENCY RANGE)
  567 FORMAT(6X,*WAVE HEADING ANGLE = *,F7.2,* DEG. *)
      NFP=NFR+1
      IF(GRAV.GT.32.) GO TO 21
      WRITE(6,20)
   20 FORMAT(10X,*PGM5 REQUIRES THAT FEET BE USED FOR LENGTH UNITS.*)
      CALL AETSKC(5LMOT35)
   21 CONST=.0081*GRAV*GRAV
      FRAD=57.295779
      FARD=0.017453293
      IF(NST.GT.0) GO TO 51
      NST=0
   51 NTS=NST+3
      STA(1)=20.0*PST
      STA(2)=0.0
      IF(NST.EQ.0) GO TO 52
      DO 50 K=1,NST
   50 STA(K+2)=STAT(K)
   52 STA(NTS)=20.0
      OMENC(1)=0.0
      OWAVE(1)=0.0
      WAVEN(1)=0.0
      ELOLA(1)=0.0
      OMEN2(1)=0.0
      HEAVE(1)=1.0
      PITCH(1)=0.0
      SSPEC(1)=0.0
      DELTA(1)=0.0
      EPSIL(1)=-1.5707963
      HEAV2(1)=1.0
      PITC2(1)=0.0
      ABMO(1)=0.0
```

```
      HSPEC(1)=0.0
      PSPEC(1)=0.0
      ADSP(1)=0.0
      AVSP(1)=0.0
      ACSP(1)=0.0
      FITCH(1)=0.0
      RDSP(1)=0.0
      RVSP(1)=0.0
      RASP(1)=0.0
      DO 250 MM=1,NBTA
      COSB=COSBET(MM)
      IF(COSB.GT.0.) GO TO 250
      DO 100 J=1,NOW
      CALL SEAST(SWH(J),AWH,HWH,ISEA,PL,PU,PME,AVP,AWL)
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,1)
      WRITE(6,17)
      WRITE (6,2)SWH(J),AWH,HWH,ISEA,PL,PU,PME,AVP,AWL
      DO 200 L=1,NOL
      FACT=SQRT(GRAV/SHLT(L))
      DO 110 N=2,NFP
      OMENC(N)=OMEN(N-1)*FACT
110   OMEN2(N)=OMENC(N)*OMENC(N)
      JJ=0
      DO 300 M=1,NSP
      JJ=JJ+1
      SOG=1.689*SPEED(M)/GRAV
      DO 120 N=2,NFP
      OWAVE(N)=FACT*WFR(JJ,N-1,MM)
      WAVEN(N) = OWAVE(N)**2/GRAV
      ELOLA(N)=SWR(JJ,N-1,MM)
      HEAVE(N)=REAL(EFH(JJ,N-1  ,MM))
      PITCH(N)=REAL(EMP(JJ,N-1,MM))*2./SHLT(L)
      HEAV2(N)=HEAVE(N)*HEAVE(N)
      PITC2(N)=PITCH(N)*PITCH(N)
      DELTA(N)=FARD*AIMAG(EFH(JJ,N-1,MM))
      EPSIL(N)=FARD*AIMAG(EMP(JJ,N-1,MM))
      SSPEC(N)=CONST/OWAVE(N)**5*EXP(-33.56/(SWH(J)**2*OWAVE(N)**4))
      HSPEC(N)=SSPEC(N)*HEAV2(N)
      PSPEC(N)=SSPEC(N)*PITC2(N)
120   FITCH(N)=0.25*SHLT(L)**2*PSPEC(N)
      DEN=OWAVE(NFP)-OWAVE(NFR)
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,1)
      WRITE(6,567) WANG(MM)
      WRITE(6,3)SWH(J),SHLT(L),SPEED(M),FN(JJ)
      WRITE(6,4)
      WRITE(6,6)(OMENC(N),OWAVE(N),ELOLA(N),SSPEC(N),HSPEC(N),FITCH(N),N
     1=1,NFP)
      NPAG=NPAG+1
      WRITE(6,1)
      WRITE(6,3)SWH(J),SHLT(L),SPEED(M),FN(JJ)
```

```
      WRITE(6,7)
      WRITE(6,8)
      WRITE(6,9)
      DO 130 N=2,NFP
      AVSP(N)=OMEN2(N)*FITCH(N)
130   ACSP(N)=OMEN2(N)*AVSP(N)
      SLOPE=(FITCH(NFP)-FITCH(NFR))/DEN
      IF(FITCH(NFP).LT.XMAX(NFP,FITCH))GOTO133
134   WRITE(6,18)
      GO TO 131
133   IF(SLOPE.LT.0.0)GOTO132
      SLOPE=AMIN1(-SLOPE,-1.0)
132   AMOT1=SIMPUN(OWAVE,FITCH,NFP)
      AMOT2=-0.5*FITCH(NFP)*FITCH(NFP)/SLOPE
      IF(AMOT2.GT.0.2*AMOT1)GOTO134
      AMOT=AMOT1+AMOT2
      AMOT=SQRT(AMOT)
      AMTA=1.2533*AMOT
      AMTS=2.0025*AMOT
      AMTO=2.5456*AMOT
      OWAK(1)=OWAVE(NFP)
      OMAK(1)=OMEN2(NFP)
      ORES(1)=FITCH(NFP)
      ORESV(1)=AVSP(NFP)
      ORESA(1)=ACSP(NFP)
      OWD=-0.25*ORES(1)/SLOPE
      DO 400 JI=2,5
      OWAK(JI)=OWAK(JI-1)+OWD
      OMAK(JI)=OWAK(JI)*(1.0+SOG*OWAK(JI))
      OMAK(JI)=OMAK(JI)*OMAK(JI)
      ORES(JI)=ORES(JI-1)+SLOPE*OWD
      ORESV(JI)=OMAK(JI)*ORES(JI)
400   ORESA(JI)=OMAK(JI)*ORESV(JI)
      ORESV(5)=0.0
      ORESA(5)=0.0
      AVEL=SIMPUN(OWAVE,AVSP,NFP)+SIMPUN(OWAK,ORESV,5)
      AVEL=SQRT(AVEL)
      AVLA =1.2533*AVEL
      AVLS=2.0025*AVEL
      AVLO=2.5456*AVEL
      AACC=SIMPUN(OWAVE,ACSP,NFP)+SIMPUN(OWAK,ORESA,5)
      AACC=SQRT(AACC)
      AACA=1.2533*AACC
      AACS=2.0025*AACC
      AACO=2.5456*AACC
      WRITE(6,10)AMTA,AMTS,AMTO,AVLA,AVLS,AVLO,AACA,AACS,AACO
      AMOT=2.0*FRAD/SHLT(L)*AMOT
      AVEL=2.0*FRAD/SHLT(L)*AVEL
      AACC=2.0*FRAD/SHLT(L)*AACC
      AMTA=1.2533*AMOT
      AMTS=2.0025*AMOT
      AMTO=2.5456*AMOT
      AVLA =1.2533*AVEL
      AVLS=2.0025*AVEL
```

```
      AVLO=2.5456*AVEL
      AACA=1.2533*AACC
      AACS=2.0025*AACC
      AACO=2.5456*AACC
      WRITE(6,16)AMTA,AMTS,AMTO,AVLA,AVLS,AVLO,AACA,AACS,AACO
131   WRITE(6,11)
      WRITE(6,12)
      WRITE(6,13)
      DO 150 K=1,NTS
      ARM=SHLT(L)*(PST-0.05*STA(K))
      CENT = SHLT(L)*(0.5 - 0.05*STA(K))
      DO 160 N=2,NFP
      ABMO(N)=HEAV2(N)+ARM**2*PITC2(N)-2.0*ARM*PITCH(N)*HEAVE(N)*COS(DEL
     1TA(N)-EPSIL(N))
      ABMOL(N,K) = SQRT(ABMO(N))
      ADSP(N)=SSPEC(N)*ABMO(N)
      AVSP(N)=OMEN2(N)*ADSP(N)
      ACSP(N)=OMEN2(N)*AVSP(N)
      TIER=WAVEN(N)*CENT*COSB
      RDSP(N)=SSPEC(N)*(ABMO(N)+1.-2.*HEAVE(N)*COS(TIER-DELTA(N))
     X   +2.*ARM*PITCH(N)*COS(TIER-EPSIL(N)))
      RDSPL(N,K) = SQRT(RDSP(N)/SSPEC(N))
      RVSP(N)=OMEN2(N)*RDSP(N)
160   RASP(N)=OMEN2(N)*RVSP(N)
      SLOPE=(ADSP(NFP)-ADSP(NFR))/DEN
      IF(ADSP(NFP).LT.XMAX(NFP,ADSP))GOTO163
164   WRITE(6,19)STA(K),WORT(1)
      GO TO 161
163   IF(SLOPE.LT.0.0)GOTO162
      SLOPE=AMIN1(-SLOPE,-1.0)
162   AMOT1=SIMPUN(OWAVE,ADSP,NFP)
      AMOT2=-0.5*ADSP(NFP)*ADSP(NFP)/SLOPE
      IF(AMOT2.GT.0.2*AMOT1)GOTO164
      AMOT=AMOT1+AMOT2
      AMOT=SQRT(AMOT)
      AMTA=1.2533*AMOT
      AMTS=2.0025*AMOT
      AMTO=2.5456*AMOT
      OWAK(1)=OWAVE(NFP)
      OMAK(1)=OMEN2(NFP)
      ORES(1)=ADSP(NFP)
      ORESV(1)=AVSP(NFP)
      ORESA(1)=ACSP(NFP)
      OWD=-0.25*ORES(1)/SLOPE
      DO 500 JI=2,5
      OWAK(JI)=OWAK(JI-1)+OWD
      OMAK(JI)=OWAK(JI)*(1.0+SOG*OWAK(JI))
      OMAK(JI)=OMAK(JI)*OMAK(JI)
      ORES(JI)=ORES(JI-1)+SLOPE*OWD
      ORESV(JI)=OMAK(JI)*ORES(JI)
500   ORESA(JI)=OMAK(JI)*ORESV(JI)
      ORESV(5)=0.0
      ORESA(5)=0.0
      AVEL=SIMPUN(OWAVE,AVSP,NFP)+SIMPUN(OWAK,ORESV,5)
```

```
      AVEL=SQRT(AVEL)
      AVLA=1.2533*AVEL
      AVLS=2.0025*AVEL
      AVLO=2.5456*AVEL
      AACC=SIMPUN(OWAVE,ACSP,NFP)+SIMPUN(OWAK,ORESA,5)
      AACC=SQRT(AACC)
      AACA=1.2533*AACC
      AACS=2.0025*AACC
      AACO=2.5456*AACC
      WRITE(6,14)STA(K),WORT(1),AMTA,AMTS,AMTO,AVLA,AVLS,AVLO,AACA,AACS,
     1AACO
161   SLOPE=(RDSP(NFP)-RDSP(NFR))/DEN
      IF(RDSP(NFP).LT.XMAX(NFP,RDSP))GOTO173
174   WRITE(6,19)STA(K),WORT(2)
      GO TO 150
173   IF(SLOPE.LT.0.0)GOTO172
      SLOPE=AMIN1(-SLOPE,-1.0)
172   RMOT1=SIMPUN(OWAVE,RDSP,NFP)
      RMOT2=-0.5*RDSP(NFP)*RDSP(NFP)/SLOPE
      IF(RMOT2.GT.0.3*RMOT1)GOTO174
      RMOT=RMOT1+RMOT2
      RMOT=SQRT(RMOT)
      RMTA=1.2533*RMOT
      RMTS=2.0025*RMOT
      RMTO=2.5456*RMOT
      OWAK(1)=OWAVE(NFP)
      OMAK(1)=OMEN2(NFP)
      ORES(1)=RDSP(NFP)
      ORESV(1)=RVSP(NFP)
      ORESA(1)=RASP(NFP)
      OWD=-0.25*ORES(1)/SLOPE
      DO 600 JI=2,5
      OWAK(JI)=OWAK(JI-1)+OWD
      OMAK(JI)=OWAK(JI)*(1.0+SOG*OWAK(JI))
      OMAK(JI)=OMAK(JI)*OMAK(JI)
      ORES(JI)=ORES(JI-1)+SLOPE*OWD
      ORESV(JI)=OMAK(JI)*ORES(JI)
600   ORESA(JI)=OMAK(JI)*ORESV(JI)
      ORESV(5)=0.0
      ORESA(5)=0.0
      RVEL=SIMPUN(OWAVE,RVSP,NFP)+SIMPUN(OWAK,ORESV,5)
      RVEL=SQRT(RVEL)
      RVLA=1.2533*RVEL
      RVLS=2.0025*RVEL
      RVLO=2.5456*RVEL
      RACC=SIMPUN(OWAVE,RASP,NFP)+SIMPUN(OWAK,ORESA,5)
      RACC=SQRT(RACC)
      RACA=1.2533*RACC
      RACS=2.0025*RACC
      RACO=2.5456*RACC
      WRITE(6,14)STA(K),WORT(2),RMTA,RMTS,RMTO,RVLA,RVLS,RVLO,RACA,RACS
     1,RACO
C        CALCULATION OF SLAM IMPACT FREQUENCY
  140 WEN = 3600. / 6.2831853 * RVEL / RMOT
```

```
      SPROB(K) = EXP(-BRCL**2 / (2.*RMOT**2) )
      SNUM(K) = WEN * SPROB(K)
      RVELS(K) = 2. * RVEL**2
      RMOTS(K) = 2. * RMOT**2
150   CONTINUE
      WRITE(6,388)
      DO 350 K=1,NTS
  350 WRITE(6,389) STA(K),BRCL, SPROB(K), SNUM(K), RVELS(K),RMOTS(K)
  388 FORMAT (1H0 // 15X, 51HCROSS DECK STR.  PROBABILITY OF     EXP.NO.
     1OF SLAMS, 9X, 8HRELATIVE, 12X,  8HRELATIVE / 6X, 58HSTATION    CLE
     2ARANCE       SLAM OCCURRENCE       IN ONE HOUR, 11X, 8HVELOCITY, 10X
     3,12HDISPLACEMENT/75X,8HVARIANCE,10X,8HVARIANCE//)
  389 FORMAT (F12.2, F13.3, 4E20.7)
  390 FORMAT(1H1,20X,2HWE,6X,7HABS MOT,3X,7HREL MOT)
  391 FORMAT(8H STATION,F7.2,/(14X,3F10.2))
      IF (J.GT.1) GO TO 300
      DO 395 K=1,NTS
      WRITE(6,390)
      WRITE(6,391) STA(K),(OMENC(LM),ABMOL(LM,K),RDSPL(LM,K),LM=2,NFP)
 395  CONTINUE
300   CONTINUE
200   CONTINUE
100   CONTINUE
  250 CONTINUE
      CALL AETSKC(5LMOT35)
      END
```

```
      SUBROUTINE SEAST(SWH,AWH,HWH,IS,TL,TU,TM,TA,WA)
      IF(SWH.GT.0.15) GO TO 1
      IS=0
      GO TO 10
1     IF(SWH.GT.1.2) GO TO 2
      IS=1
      GO TO 10
2     IF(SWH.GT.3.0) GO TO 3
      IS=2
      GO TO 10
3     IF(SWH.GT.5.0) GO TO 4
      IS=3
      GO TO 10
4     IF(SWH.GT.7.5) GO TO 5
      IS=4
      GO TO 10
5     IF(SWH.GT.12.0) GO TO 6
      IS=5
      GO TO 10
6     IF(SWH.GT.20.0) GO TO 7
      IS=6
      GO TO 10
7     IF(SWH.GT.40.0) GO TO 8
      IS=7
      GO TO 10
8     IF(SWH.GT.60.0) GO TO 9
      IS=8
      GO TO 10
9     IS=9
10    QWH=SQRT(SWH)
      AWH=0.62585*SWH
      HWH=1.27119*SWH
      TL=1.0905712*QWH
      TU=3.4343965*QWH
      TA=1.9608164*QWH
      TM=2.7602723*QWH
      WA=13.135862*SWH
      RETURN
      END
```

```
      OVERLAY(6,0)
      PROGRAM PGM1A
C
C   FOLLOWING SEA DISPATCH TASK
C      REENTERED FOR EACH OF 3 CASES (KASE=1,2,3)
C
C   THIS TASK SAVES ALL THE DATA ACCUMULATED SO FAR,
C      AND REINITIALIZES BEFORE EACH CASE (DATA IS SAVED ON TAPE48)
C
C
      COMMON/HP1/  NPAG,TITLE(8),PATT(7),RATIO
      COMMON/HP2/  ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/HP3/  NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MAS(30),
     X             AVBM(30),ST(30),IN(30),SQAR(30),X(30,20),Y(30,20)
      COMMON/HP4/  NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/HP5/  VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/HP6/  NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/HP7/  NFN,NFNS,FN(6),FNS(6)
      COMMON/HP8/  NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/HP9/  NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWX
      COMMON/HP10/ XZFO,XZVL,XZHB,XZPB,KV,KW
      COMMON/HP11/ CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/HP12/ CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/HP13/ GRAV,DEPCAT,SD(6),RBMST(10)
      COMMON/HP14/ EL,GCB,GYR,RGY,VCG,BRCL,RP33,RP35,RM55
      COMMON/HP15/ A33(30),A35(4,30),A53(4,30),A55(4,30),C35S,C55S,
     X             B33(4,30,3),B35(4,30,3),B53(4,30,3),B55(4,30,3)
      COMMON/HP16/ AHP(30),DHP(4,30),AP(30),DP(4,30)
      COMMON/HP17/ OMEGA,UN,PAH(19),PVH(19)
      COMMON/HP18/ BLOG(19,19),YLOG(19,19)
      COMMON/HP19/ KASE(4),MIL(4),CWR1(4),CWR2(4),WFP(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/HP20/ II,EFH(4,30,3),EMP(4,30,3),EMK(4,30,3)
      COMPLEX II,EFH,EMP
C
C   END OF COMMON DECK
C      (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
C
C   BYPASS IF HEAD SEA
C
      IF(JA.NE.2) CALL AETSKC(5LPGM1B)
      IF(KASE(1).GT.0) GO TO 21
      NBTAS=NBTAS+1
      IF(WANG(NBTAS).LT.90.) GO TO 20
      JA=1
      JB=1
      JC=1
      NBTA=NBTAT-NBTAQ
      DO 22 MM=1,NBTA
   22 WANG(MM)=WANG(MM+NBTAQ)
```

```
      DO 18 I=1,NFRS
   18 OMEN(I)=OMENS(I)
      NFR=NFRS
      DO 19 I=1,NFNS
   19 FN(I)=FNS(I)
      NFN=NFNS
      CALL AETSKC(5LPGM18)
   20 JA=2
      JB=3
      NBTA=1
      DO 17 I=1,NFNS
   17 FN(I)=FNS(I)
      NFN=NFNS
      WANG(1)=WANG(NBTAS)
   21 MM=1
      COSB=COS(WANG(MM)*.01745326252)
C
C   COMPUTE DATA LENGTH AND CONSTANTS
C
      N=LOCF(ENDCOM)-LOCF(TITLE(1))
      TWOPI=6.28318531
      MPAG=NPAG
C
C   DISPATCH BY ENTERING KASE
C
      GO TO (100,200,300,77), KASE(1)+1
C
C   CASE 1
C
 100  CONTINUE
      IF(OMIN.LE.0. .OR. OMAX.LE.0.) GO TO 77
      KASE(1)=1
C
      NPAG=NPAG+1
    5 FORMAT(1H1,14A6,18X,A6,I4/)
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,6) WANG(MM)
    6 FORMAT(1H0,10X,*BETA = *,F10.1//11X,*QUARTERING SEA  KASE=1 ,*,
     X  *HIGH FREQUENCY WAVES FASTER THAN SHIP*)
C
C
C   WRITE OUT INITIALIZATION OF DATA
C
      REWIND 48
      WRITE(48) (TITLE(I),I=1,N)
C
C   CALCULATE MINIMUM FN AT INTERCEPT OF
C      MINIMUM RWS+DELTA LINE  AND  CRITICAL CURVE
C
C    RWS BOUNDS ARE IN RWS(1,N,1)    N=1,NB
C    DELTAS ARE IN RWS(2,N,1)
C
      NB=RWS(3,1,1)
C
```

```
      A=(RWS(1,1,1)+RWS(2,1,1))/TWOPI
      FNMIN=SQRT(A)/(2.*COSB)
C
C   CALCULATE MAXIMUM FN AT INTERCEPT OF
C      MAXIMUM RWS-DELTA LINE AND OMIN LINE
C
      A=(RWS(1,NB,1)-RWS(2,NB-1,1))/TWOPI
      SA=SQRT(A)
      FNMAX=SA*(1.-OMIN*SA)/COSB
C
      WRITE (6,7) FNMIN,FNMAX
 7    FORMAT(1H0,20X,*SPEED RANGE OF INTEREST FROM FROUDE NUMBER *,
     1      F7.4,* TO *,F7.4//)
C
C   REDEFINE SPEED ARRAY TO INCLUDE JUST ABOVE RANGE
C
      IJ=0
      DO 111 JJ=1,NFN
      IF(FN(JJ).LT.FNMIN .OR. FN(JJ).GT.FNMAX) GO TO 111
      IJ=IJ+1
      FN(IJ)=FN(JJ)
 111  CONTINUE
C
C   IF NO DESIRED SPEEDS ARE IN RANGE, GO TO NEXT CASE
C
      IF(IJ.EQ.0) GO TO 200
      NFN=IJ
C
C   LOOP THRU FN VALUES TO FIND APPLICABLE OMEGA RANGES
C
      DO 121 JJ=1,NFN
C
C   FIND MINIMUM OMEGA AT INTERCEPT OF MINIMUM RWS
C
C    USE WN(JJ,1,1) FOR MINIMUM OMEGA FOR FN(JJ)
C        WN(JJ,2,1) FOR MAXIMUM OMEGA
C        WFR(JJ,1,1) FOR MINIMUM RWS
C        WFR(JJ,2,1) FOR MAXIMUM RWS
C
      FNB=FN(JJ)*COSB
      A=RWS(1,1,1)/TWOPI
      SA=1.0/SQRT(A)
      WN(JJ,1,1)=SA*(1.-FNB*SA)
      IF(WN(JJ,1,1).LT.OMIN) WN(JJ,1,1)=OMIN
      OMEG=(1.+SQRT(1.-4.*FNB*WN(JJ,1,1)))/FNB*.5
      WFR(JJ,1,1)=TWOPI/(OMEG*OMEG)
C
C   FIND MAXIMUM OMEGA AT INTERCEPT OF
C      MAXIMUM RWS  OR AT CRITICAL CURVE
C
      A=RWS(1,NB,1)/TWOPI
      SA=1.0/SQRT(A)
      CRITFN=.5/(SA*COSB)
```

```
      IF(FN(JJ).LT.CRITFN) WN(JJ,2,1)=.25/FNB
      IF(FN(JJ).GE.CRITFN) WN(JJ,2,1)=SA*(1.-FNB*SA)
      IF(WN(JJ,2,1).GT.OMAX) WN(JJ,2,1)=OMAX
      OMEG=(1.+SQRT(1.-4.*FNB*WN(JJ,2,1)))/FNB*.5
      WFR(JJ,2,1)=TWOPI/(OMEG*OMEG)
C
 121  CONTINUE
      GO TO 500
C
C   CASE 2
C
 200  CONTINUE
C
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,8)  WANG(MM)
    8 FORMAT(1H0,10X,*BETA = *,F10.1//11X,*QUARTERING SEA  KASE=2,*,
     1      * LOW FREQUENCY WAVES FASTER THAN SHIP*)
C
C   READ BACK INITIAL DATA
C
      REWIND 48
      READ(48) (TITLE(I),I=1,N)
      NPAG=MPAG+1
C
      NB=RWS(3,1,1)
C
      KASE(1)=2
C
C   CALCULATE MINIMUM FN AS FIRST NON-ZERO FN
C
      FNMIN=0.0000001
C
C   CALCULATE MAXIMUM FN AS INTERCEPT OF
C     MAXIMUM RWS-DELTA LINE AND CRITICAL CURVE
C
      A=(RWS(1,NB,1)-RWS(2,NB-1,1))/TWOPI
      FNMAX=SQRT(A)/(2.*COSB)
C
      WRITE (6,7) FNMIN,FNMAX
C
C   REDEFINE SPEEDS ARRAY
C
      IJ=0
      DO 211 JJ=1,NFN
      IF(FN(JJ).LT.FNMIN .OR. FN(JJ).GT.FNMAX) GO TO 211
      IJ=IJ+1
      FN(IJ)=FN(JJ)
 211  CONTINUE
      IF(IJ.EQ.0) GO TO 300
      NFN=IJ
C
C   FIND APPLICABLE OMEGA RANGES
C
```

```
      DO 221 JJ=1,NFN
C
C   FIND MINIMUM OMEGA (MAXIMUM RWS) AT INTERCEPT OF
C      MAXIMUM RWS LINE AND FN
C
      FNB=FN(JJ)*COSB
      A=RWS(1,NB,1)/TWOPI
      SA=1.0/SQRT(A)
      WN(JJ,1,1)=SA*(1.-FNB*SA)
      WFR(JJ,2,1)=RWS(1,NB,1)
C
C   FIND MAXIMUM OMEGA AS INTERCEPT OF MINIMUM RWS
C      OR CRITICAL OMEGA
C
      A=RWS(1,1,1)/TWOPI
      SA=1.0/SQRT(A)
      CRITFN=.5/(SA*COSB)
C
      IF(FN(JJ).GT.CRITFN) WN(JJ,2,1)=.25/FNB
      IF(FN(JJ).LE.CRITFN) WN(JJ,2,1)=SA*(1.-FNB*SA)
      IF(WN(JJ,2,1).GT.CMAX) WN(JJ,2,1)=OMAX
C
      OMEG=(1.-SQRT(1.-4.*FNB*WN(JJ,2,1)))/FNB*.5
      WFR(JJ,1,1)=TWOPI/(CMEG*OMEG)
C
 221  CONTINUE
      GO TO 500
C
C
C   KASE=3
C
 300  CONTINUE
C
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,6),(TITLE(I),I=1,8),PATT(7),NPAG
      WRITE(6,9) WANG(MM)
    9 FORMAT(1H0,10X,*BETA = *,F10.1//11X,*QUARTERING SEA  KASE=3 ,*,
     1      * SHIP FASTER THAN WAVES*)
C
C   READ BACK INITIAL DATA
C
      REWIND 48
      READ(48) (TITLE(I),I=1,N)
      NPAG=MPAG+1
C
      NB=RWS(3,1,1)
C
      KASE(1)=3
C
C
C   CALCULATE MINIMUM FN AS INTERCEPT OF
C      MINIMUM RWS+DELTARWS AND MINIMUM OMEGA
C
      A=(RWS(1,1,1)+RWS(2,1,1))/TWOPI
```

```
      SA=SQRT(A)
      FNMIN=SA*(1.+OMIN*SA)/COSB
C
C   CALCULATE MAXIMUM FN AS INTERCEPT OF
C      MAXIMUM RWS-DELTARWS AND MAXIMUM OMEGA
C
      A=(RWS(1,NB,1)-RWS(2,NB-1,1))/TWOPI
      SA=SQRT(A)
      FNMAX=SA*(1.+OMAX*SA)/COSB
C
      WRITE (6,7) FNMIN,FNMAX
C
C   REDEFINE SPEEDS ARRAY
C
      IJ=0
      DO 311 JJ=1,NFN
      IF(FN(JJ).LT.FNMIN .OR. FN(JJ).GT.FNMAX) GO TO 311
      IJ=IJ+1
      FN(IJ)=FN(JJ)
 311  CONTINUE
C
C   IF NO DESIRED SPEEDS, GO TO NEXT CASE
C
      IF(IJ.EQ.0) GO TO 77
      NFN=IJ
C
C   FIND APPLICABLE OMEGA RANGES FOR EACH FN
      DO 321 JJ=1,NFN
C
C   CALCULATE MINIMUM OMEGA AS INTERCEPT
C      OF MAXIMUM RWS
C
      FNB=FN(JJ)*COSB
      A=RWS(1,NB,1)/TWOPI
      SA=-1.0/SQRT(A)
      WN(JJ,1,1)=SA*(1.+FNB*SA)
      IF(WN(JJ,1,1).LT.OMIN) WN(JJ,1,1)=OMIN
      OMEG=(1.+SQRT(1.+4.*FNB*WN(JJ,1,1)))/FNB*.5
      WFR(JJ,2,1) =TWOPI/(OMEG*OMEG)
C
C   CALCULATE MAXIMUM OMEGA AS INTERCEPT
C      OF MINIMUM RWS
C
      A=RWS(1,1,1)/TWOPI
      SA=-1.0/SQRT(A)
      WN(JJ,2,1)=SA*(1.+FNB*SA)
      IF(WN(JJ,2,1).GT.OMAX) WN(JJ,2,1)=OMAX
      OMEG=(1.+SQRT(1.+4.*FNB*WN(JJ,2,1)))/FNB*.5
      WFR(JJ,1,1)=TWOPI/(OMEG*OMEG)
C
C
 321  CONTINUE
C
C
C   END OF FOLLOWING SEA RUN
```

```
C    CHOOSE DELTA OMEGA AND LOAD OMEGA ARRAY
C
 500  CONTINUE
C
C
C    FOR EACH FN    FN(JJ)   JJ=1,NFN
C
C        WN(JJ,1,1)     CONTAINS MINIMUM OMEGA
C        WN(JJ,2,1)     CONTAINS MAXIMUM OMEGA
C        WFR(JJ,1,1)    CONTAINS MINIMUM RWS
C        WFR(JJ,2,1)    CONTAINS MAXIMUM RWS
C
C     FOR EACH BOUNDARY  RWS(1,N,1)  N=1,NB    NB=RWS(3,1,1)
C
C        RWS(2,I,1)   CONTAINS DELTA RWS FOR RANGE
C                     RWS(1,I,MM) TO RWS(1,I+1,MM)
C
C    RWS IS REAL WAVE LENGTH DIVIDED BY LENGTH OF SHIP
C
      WRITE(6,10) (FN(I),WN(I,1,1),WN(I,2,1),WFR(I,1,1),WFR(I,2,1),
     X  I=1,NFN)
 10   FORMAT(10X,*AT FROUDE NUMBER=*,F7.4,* FREQUENCY RANGE IS *,
     1      F7.4,* TO *,F7.4,* AND WAVE LENGTH RANGE IS *,
     2      F7.4,* TO *,F7.4)
C
      RWS(1,NB,1)=RWS(1,NB,1)+1.0
      NB=NB-1
      OMIN=100.0
      OMAX=0.0
      DOME=100.0
C
C    FIND MINIMUM OMEGA MINIMUM
C         MAXIMUM OMEGA MAXIMUM
C
      DO 511 JJ=1,NFN
      IF(WN(JJ,1,1).LT.OMIN) OMIN=WN(JJ,1,1)
      IF(WN(JJ,2,1).GT.OMAX) OMAX=WN(JJ,2,1)
 511  CONTINUE
C
C    LOAD OMEGA ARRAY FROM LOWEST FREQUENCY
C      CLIP HIGHER FREQUENCIES IF BEYOND BOUNDS  (50 FREQUENCIES)
C
      DOMEMIN=OMIN/EL
      NFR=1
      OMEN(1)=OMIN
      DO 531 N=2,30
C
C    FIND MINIMUM DELTA OMEGA AT OMEGA AND ALL SPEEDS
C
      DOME=100.0
      DO 525 JJ=1,NFN
C
      FNB=FN(JJ)*COSB
      IF(OMEN(N-1).GE.WN(JJ,2,1))  GO TO 525
      IF(OMEN(N-1).GE.WN(JJ,1,1)) GO TO 520
      DELTA=WN(JJ,1,1)-OMEN(N-1)
```

```
      IF(DELTA.LT.DOME) DOME=DELTA+0.00001
      GO TO 525
C
 520  CONTINUE
C
      FNB2=2.*FNB
      DELTA=WN(JJ,2,1)-OMEN(N-1)
      IF(DELTA.LT.DOME) DOME=DELTA
C
      IF(KASE(1).EQ.1) OMEG=(1.+SQRT(1.-4.*FNB*OMEN(N-1)))/FNB2
      IF(KASE(1).EQ.2) OMEG=(1.-SQRT(1.-4.*FNB*OMEN(N-1)))/FNB2
      IF(KASE(1).EQ.3) OMEG=(1.+SQRT(1.+4.*FNB*OMEN(N-1)))/FNB2
      RWSS=TWOPI/(OMEG*OMEG)
C
      DO 521 I=1,NB
      IF(RWSS.GT.RWS(1,I+1,1)) GO TO 521
C
      A=RWSS/TWOPI
      SA=SQRT(A)
      DA=RWS(2,I,1)/TWOPI
      DELTA=ABS((FNB/(A*A)-.5/(SA*SA*SA))*DA)
      IF((OMEN(N-1)+1.5*DELTA).GT.WN(JJ,2,1))
     1  DELTA=WN(JJ,2,1)-OMEN(N-1)
      GO TO 522
C
 521  CONTINUE
C
 522  CONTINUE
      IF(DELTA.LT.DOME) DOME=DELTA
C
 525  CONTINUE
      IF(DOME.LT.DOMEMIN) DOME=DOMEMIN
      OMEN(N)=OMEN(N-1)+DOME
      NFR=NFR+1
C
      IF(OMEN(N).LT.(OMAX-0.00001)) GO TO 531
      OMEN(N)=OMAX
      GO TO 532
C
 531  CONTINUE
 532  CONTINUE
C
      WRITE (6,11) NFR,OMEN(1),OMEN(NFR)
 11   FORMAT(1H0,6X,*ANALYSIS WILL BE BASED ON *,I2,
     1      * FREQUENCIES  FROM *,F7.4,* TO *,F7.4)
C
C
C   GO EXECUTE ANALYSIS
C
      CALL AETSKC(5LPGM1B)
 77   CONTINUE
      KASE(1)=0.
      IF(WANG(NBTAS+1).EQ.777.) JC=3
      IF(ID.EQ.2 .OR. ID.EQ.-1) CALL AETSKC(5LMOT35)
      IF(LP.EQ.0 .AND. IP.EQ.0 .AND. NOW.EQ.0) CALL AETSKC(5LMOT35)
      IF(LP.LE.0 .AND. IP.LE.0) CALL AETSKC(4LPGM5)
      END
```

APPENDIX B

PROGRAM LISTING OF MOT246

```
      OVERLAY(OVFILE,0,0)
      PROGRAM MAIN(INPUT=512,OUTPUT=512,TAPE23=512,TAPE48=512,
     X  TAPE5=INPUT,TAPE6=OUTPUT)
C
C
      COMMON/SRY1/ NPAG,TITLE(8),PATT(8),RATIO
      COMMON/SRY2/ ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/SRY3/ NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X             DMA(30),AVDA(30),AVBM(30),ST(30),IN(30),SQAR(30),
     X             X(30,20),Y(30,20)
      COMMON/SRY4/ NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/SRY5/ VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/SRY6/ NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/SRY7/ NFN,NFNS,FN(6),FNS(6)
      COMMON/SRY8/ NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/SRY9/ NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/SRY10/XZHB,XZPB,XZFO,XZVL,KV,KW
      COMMON/SRY11/CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/SRY12/CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/SRY13/GRAV,DEPCAT,SD(6),RBMST(10),RBMHT(10)
      COMMON/SRY14/EL,GCB,GYR,GYRT,GM,GMT,GMTS,VCG,RF33,RP35,RM55
      COMMON/SRY15/A26(4,30),A62(4,30),A46(4,30),A64(4,30),A66(4,30)
      COMMON/SRY16/A22(30),A44(30),A24(30),DSR(30),DRR(30)
      COMMON/SRY17/ASY(30),DSY(4,30),AY(30),DY(4,30),ARY(30),DRY(30)
      COMMON/SRY18/B22(4,30),B26(4,30),B62(4,30),B46(4,30),B64(4,30),
     X             B66(4,30),B24(4,30),B44(4,30,3)
      COMMON/SRY19/OMEGA,UN,PAS(19),PVS(19),PAR(19),PVR(19)
      COMMON/SRY20/BLOG(19,19),YLOG(19,19)
      COMMON/SRY21/KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/SRY22/II,EFS,EMR,EMY,EKR(4,30,3),EKY(4,30,3)
      COMPLEX II,EFS(4,30,3),EMR(4,30,3),EMY(4,30,3)
C
C   END OF COMMON DECK
C      (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
      DATA PATT/6H MOT24,6H6   SW,6HAY, RO,6HLL AND,6H YAW M,6HOTIONS,
     X  6H OF   ,6H  PAGE/
      NBTAS=0
      GO TO 1001
      CALL FLAGSV
      CALL PLOTDD
 1001 CONTINUE
      JC=0
      CALL AETSKC(6LMOT246)
       END
C ****NOTE***THE FUNCTIONS XMIN, XMAX, SIMPUN, AND ATAN3 AND THE
C ****SUBROUTINES NILS, DAVID, MATINS, AND SEAST ARE THE SAME FOR BOTH
C ****MOT35 AND MOT246.  THE SUBROUTINE QDFCN AND THE PROGRAMS PGM4 AND
C ****PGM1A ARE THE SAME FOR MOT35 AND MOT246 EXCEPT FOR THE COMMON
C ****BLOCKS AND THE REFERENCES TO MOT35.
C ****SUBSTITUTE THE COMMON BLOCKS SRY1-SRY22 FOR HP1-HP20.
C ****CHANGE STATEMENTS AT THE END OF PGM4 AND PGM1A FROM
C ****CALL AETSKC(5LMOT35) TO CALL AETSKC(6LMOT246).
C ****THE ABOVE ROUTINES WILL NOT BE REPEATED IN THE MOT246 LISTING.
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      OVERLAY(1,0)
      PROGRAM MOT246
C
C     OFFSETS MUST BE READ IN. THE X AXIS IS THE TRANVERSE BASE LINE OF
C     STATION 10. THE Y AXIS IS THE VERTICAL CENTER LINE OF STATION 10.
C     Y IS POSITIVE UP AND X IS POSITIVE TO THE RIGHT.
C     LOOKING FORWARD ON THE STARBOARD HULL AND STARTING AT THE BOW THE
C     OFFSETS ARE READ IN COUNTER-CLOCK WISE A STATION AT A TIME.
C     HULL SEPARATION DISTANCE MUST ALSO BE GIVEN. IT IS IDENTIFIED AS
C     SD(NSD) WHERE NSD IS THE NUMBER OF HULL SEPARATIONS TO BE RUN.
C     THE HULL SEPARATION IS THE DISTANCE FROM THE CENTER LINE OF THE
C     CATAMARAN TO THE CENTER LINE OF STATION 10.
C
C
      COMMON/SRY1/ NPAG,TITLE(8),PATT(8),RATIO
      COMMON/SRY2/ ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/SRY3/ NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X             DMA(30),AVDA(30),AVBM(30),ST(30),IN(30),SQAR(30),
     X             X(30,20),Y(30,20)
      COMMON/SRY4/ NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/SRY5/ VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/SRY6/ NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/SRY7/ NFN,NFNS,FN(6),FNS(6)
      COMMON/SRY8/ NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/SRY9/ NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/SRY10/XZHB,XZPB,XZFO,XZVL,KV,KW
      COMMON/SRY11/CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/SRY12/CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/SRY13/GRAV,DEPCAT,SD(6),RBMST(10),RBMHT(10)
      COMMON/SRY14/EL,GCB,GYR,GYRT,GM,GMT,GMTS,VCG,RF33,RP35,RM55
      COMMON/SRY15/A26(4,30),A62(4,30),A46(4,30),A64(4,30),A66(4,30)
      COMMON/SRY16/A22(30),A44(30),A24(30),DSR(30),DRR(30)
      COMMON/SRY17/ASY(30),DSY(4,30),AY(30),DY(4,30),ARY(30),DRY(30)
      COMMON/SRY18/B22(4,30),B26(4,30),B62(4,30),B46(4,30),B64(4,30),
     X             B66(4,30),B24(4,30),B44(4,30,3)
      COMMON/SRY19/OMEGA,UN,PAS(19),PVS(19),PAR(19),PVR(19)
      COMMON/SRY20/BLOG(19,19),YLOG(19,19)
      COMMON/SRY21/KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/SRY22/II,EFS,EMR,EMY,EKR(4,30,3),EKY(4,30,3)
      COMPLEX II,EFS(4,30,3),EMR(4,30,3),EMY(4,30,3)
C
C    END OF COMMON DECK
C       (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
      DIMENSION YJK(20),YBG(30)
    1 FORMAT(8A6)
    2 FORMAT(12I5)
    3 FORMAT(8F10.5)
    4 FORMAT(4F9.4,2I9)
    5 FORMAT(1H1,15A6,18X,A6,I4/)
```

```
    6 FORMAT(1H0,5X,54HSTATION 10.0 NOT GIVEN - READ INPUT DATA FOR NEXT
     1 SHIP)
    7 FORMAT(4F10.5,2I5)
8     FORMAT(1H0,5X,23HCOMPUTED FROUDE NUMBERS)
    9 FORMAT(/* DATA INPUT CARDS*/ 10X,*1*,9X,*2*,9X,*3*,9X,*4*,9X,
     X  *5*,9X,*6*,9X,*7*,9X,*8*/1X,8(*1234567890*))
   40 FORMAT(8F9.4)
   51 FORMAT(1X,8A6)
   52 FORMAT(1X,12I5)
   53 FORMAT(1X,8F10.5)
   54 FORMAT(1X,4F9.4,2I9)
   57 FORMAT(1X,4F10.5,2I5)
 3000  FORMAT(12H1 END OF JOB)
  335 FORMAT(30X,9HSTATION   ,F9.4)
   78 NPAG=0
      IF(JC.EQ.2 .AND. NBTAS.GT.0) CALL AETSKC(5LPGM1A)
       ID = 1
      READ(5,1)  (TITLE(I),I=1,8)
      READ(5,2)  MONO,JA
      IF(JA.LE.0) GO TO 77
      READ(5,3)  SCALE,GRAV
      READ(5,2)  NFR,NBTA,NFN,NSD,NSTR,NOS,NLOOP,IG,LP,IND
      READ(5,3)  (OMEN(I),I=1,NFR)
      READ(5,3)  (WANG(I),I=1,NBTA)
      READ(5,3)  (FN(I),I=1,NFN)
      READ(5,3)  (SD(I),I=1,NSD)
      READ(5,3)  (RBMST(I),I=1,NSTR)
      READ(5,3)  (RBMHT(I),I=1,NSTR)
      OMIN=OMEN(1)
      NBTAT=NBTA
      NBTAS=0
      WANG(NBTAT+1)=777.
      NBTAQ=0
      DO 17 I=1,NBTA
      IF(WANG(I).LT.90.) NBTAQ=NBTAQ+1
   17 CONTINUE
      NFRS=NFR
      DO 18 I=1,NFR
   18 OMENS(I)=OMEN(I)
      JC=1
      IF(NBTAQ.NE.0) JC=2
      JB=1
      DO 19 I=1,NFN
   19 FNS(I)=FN(I)
      NFNS=NFN
      KASE(1)=0
      NPAG=NPAG+1
      WRITE(6,5)  (PATT(I),I=1,7),(TITLE(I),I=1,8),PATT(8),NPAG
      WRITE(6,9)
      WRITE(6,51)  (TITLE(I),I=1,8)
      WRITE(6,52)  MONO,JA
      WRITE(6,53)  SCALE,GRAV
      WRITE(6,52)  NFR,NBTA,NFN,NSD,NSTR,NOS,NLOOP,IG,LP,IND
      WRITE(6,53)  (OMEN(I),I=1,NFR)
```

```
      WRITE(6,53)  (WANG(I),I=1,NBTA)
      WRITE(6,53)  (FN(I),I=1,NFN)
      WRITE(6,53)  (SD(I),I=1,NSD)
      WRITE(6,53)  (RBMST(I),I=1,NSTR)
      WRITE(6,53)  (RBMHT(I),I=1,NSTR)
      IF(SCALE.LE.0.) SCALE=1.
      IF(GRAV.LE.0.) GRAV=32.174
      IF(NSD.GE.1) GO TO 79
      NSD=1
      SD(1)=0.
   79 IF(JC.NE.2) GO TO 43
      IF(JA.NE.2) GO TO 43
      IF(NFN.GE.1) GO TO 144
      JB=1
      FN(1)=0.0
      GO TO 43
 144  CONTINUE
C
C     FOLLOWING OR QUARTERING SEA CASE
C
C    READ IN BOUNDS FOR RWS AND DELTA RWS
C       (RWS IS REAL WAVE LENGTH / LENGTH OF SHIP)
C
C     STORE BOUNDS IN    RWS(1,N,1)   N=1,NB
C           INCREMENTS   RWS(2,N,1)   N=1,NB-1
C           NUMBER OF BOUNDS IN RWS(3,1,1)
C
C     BOUNDS MUST BE IN ASCENDING ORDER FROM MINIMUM TO MAXIMUM
C
      READ(5,3)  (RWS(1,N,1),N=1,8)
      READ(5,3)  (RWS(2,N,1),N=1,8)
      READ(5,3)  OMIN,OMAX,DOME
C
      NB=0
      DO 301 I=1,8
      IF(RWS(1,I,1).LE.0.0 ) GO TO 302
      NB=NB+1
 301  CONTINUE
 302  CONTINUE
      RWS(3,1,1)=NB
C
      WRITE(6,3)  (RWS(1,N,1),N=1,NB)
      NB=NB-1
      WRITE(6,3)  (RWS(2,N,1),N=1,NB)
      WRITE(6,3) OMIN,OMAX,DOME
   43 READ(5,3) EL,GYR,GYRT,GCB,VCG,GMT,DEPCAT,BRCL
      READ(5,3) FAL,FAY,DEPA,CHRDA,SPNA,THKA,CLFA,XZFA
      READ(5,3) FBL,FBY,DEPB,CHRDB,SPNB,THKB,CLFB,XZFB
      READ(5,7) XZFO,XZVL,XZHB,XZPB,KV,KW
      READ(5,4)  (ST(I),BEAM(I),DRFT(I),AREA(I),NM(I),MPS(I),I=1,NOS)
      WRITE(6,53) EL,GYR,GYRT,GCB,VCG,GMT,DEPCAT,BRCL
      WRITE(6,53) FAL,FAY,DEPA,CHRDA,SPNA,THKA,CLFA,XZFA
      WRITE(6,53) FBL,FBY,DEPB,CHRDB,SPNB,THKB,CLFB,XZFB
      WRITE(6,57) XZFO,XZVL,XZHB,XZPB,KV,KW
      WRITE(6,54)  (ST(I),BEAM(I),DRFT(I),AREA(I),NM(I),MPS(I),I=1,NOS)
```

```
      MS=0
      DO 30 I=1,NOS
      IF(ST(I).NE.10.) GO TO 30
      MS=I
      GO TO 31
   30 CONTINUE
      MS=0
   31 NIX=NM(1)
      DO 10 I=2,NOS
      IF(NIX.GE.NM(I)) GO TO 10
      NIX=NM(I)
   10 CONTINUE
      IN(1)=IABS(NM(1))
      NUX=IN(1)
      DO 20 I=2,NOS
      IN(I)=IABS(NM(I))
      IF(NUX.GE.IN(I)) GO TO 20
      NUX=IN(I)
   20 CONTINUE
      DO 21 I=1,NOS
      BEAM(I)=BEAM(I)*SCALE
   21 DRFT(I)=DRFT(I)*SCALE
      IF(NUX.LE.0) GO TO 13
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,7),(TITLE(I),I=1,8),PATT(8),NPAG
      KIM=0
      DO 11 I=1,NOS
      YBG(I)=0.
      IF(IN(I).LE.0) GO TO 11
      LEE=3
      NUT=IN(I)
      IF(NUT.LE.8) GO TO 14
      LEE=5
   14 KIM=KIM+LEE
      IF(KIM.LE.50) GO TO 15
      KIM=LEE
      NPAG=NPAG+1
      WRITE(6,5) (PATT(J),J=1,7),(TITLE(J),J=1,8),PATT(8),NPAG
   15 WRITE(6,335) ST(I)
      READ(5,40) (X(I,J),J=1,NUT)
      READ(5,40) (Y(I,J),J=1,NUT)
      WRITE(6,40) (X(I,J),J=1,NUT)
      WRITE(6,40) (Y(I,J),J=1,NUT)
      DO 165 J=1,NUT
      X(I,J)=X(I,J)*SCALE
      Y(I,J)=Y(I,J)*SCALE
  165 YJK(J)=Y(I,J)
      YLGS=XMAX(NUT,YJK)
      YSML=XMIN(NUT,YJK)
      DRFT(I)=YLGS-YSML
      YBG(I)=YLGS
   11 CONTINUE
   13 IF(SCALE.EQ.1.) GO TO 23
      EL=EL*SCALE
      VCG=VCG*SCALE
```

```
      GMT=GMT*SCALE
      DEPCAT=DEPCAT*SCALE
      BRCL=BRCL*SCALE
      DO 22 I=1,NSD
   22 SD(I)=SD(I)*SCALE
      DO 24 I=1,NSTR
   24 RHMHT(I)=RHMHT(I)*SCALE
   23 READ(5,2) NOW,NOL,NSP,NST
      IF(NOW.LE.0) GO TO 75
      READ(5,3)  (WINK(I),I=1,NOW)
      READ(5,3)  (SHLT(I),I=1,NOL)
      READ(5,3)  (SPEED(I),I=1,NSP)
      READ(5,3)  (STAT(I),I=1,NST)
      WRITE(6,3)  (WINK(I),I=1,NOW)
      WRITE(6,3)  (SHLT(I),I=1,NOL)
      WRITE(6,3)  (SPEED(I),I=1,NSP)
      WRITE(6,3)  (STAT(I),I=1,NST)
      NFN=NOL*NSP
      IF(NFN.GT.4 .OR. JB.EQ.3 .OR. JA.NE.1) GO TO 77
      OMAX=OMAX
      WRITE(6,8)
      JJ=0
      FACT=1.688
      IF(GRAV.LT.32.) FACT=.3048*FACT
      DO 150 L=1,NOL
      DO 150 M=1,NSP
      JJ=JJ+1
  150 FN(JJ)=FACT*SPEED(M)/SQRT(GRAV*SHLT(L))
      WRITE(6,3)  (FN(JJ),JJ=1,NFN)
   75 IF(MS.NE.0) GO TO 69
      WRITE(6,6)
      GO TO 78
   69 DUM=XMAX(NOS,YBG)
      DO 16 I=1,NOS
      NUT=IN(I)
      IF(NUT.LE.0) GO TO 16
      DO 12 J=1,NUT
   12 Y(I,J)=Y(I,J)-DUM
   16  CONTINUE
      CALL AETSKC(4LPGM1)
   77 IF(LP.LE.0 .AND. IP.LE.0) GO TO 80
       ENDFILE 48
       ENDFILE 48
       REWIND 48
   80 IF(IND.EQ.0) GO TO 777
      I=777
      WRITE(23) I,I,I
      ENDFILE 23
      REWIND 23
  777 WRITE(6,3000)
      END

C     ****FUNCTIONS XMIN, XMAX, AND SIMPUN NOT LISTED--SEE MOT35 LISTING****
```

```
      OVERLAY(2,0)
      PROGRAM PGM1
C
C
      COMMON/SRY1/ NPAG,TITLE(8),PATT(8),RATIO
      COMMON/SRY2/ ID,IG,IP,IND,ISU,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/SRY3/ NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X             OMA(30),AVDA(30),AVBM(30),ST(30),IN(30),SQAR(30),
     X             X(30,20),Y(30,20)
      COMMON/SRY4/ NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/SRY5/ VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/SRY6/ NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/SRY7/ NFN,NFNS,FN(6),FNS(6)
      COMMON/SRY8/ NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/SRY9/ NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/SRY10/XZHB,XZPR,XZFO,XZVL,KV,KW
      COMMON/SRY11/CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/SRY12/CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/SRY13/GRAV,DEPCAT,SD(6),RBMST(10),RBMHT(10)
      COMMON/SRY14/EL,GCH,GYR,GYRT,GM,GMT,GMTS,VCG,RF33,RP35,RM55
      COMMON/SRY15/A26(4,30),A62(4,30),A46(4,30),A64(4,30),A66(4,30)
      COMMON/SRY16/A22(30),A44(30),A24(30),DSR(30),DRR(30)
      COMMON/SRY17/ASY(30),DSY(4,30),AY(30),DY(4,30),ARY(30),DRY(30)
      COMMON/SRY18/B22(4,30),B26(4,30),B62(4,30),B46(4,30),B64(4,30),
     X             B66(4,30),B24(4,30),B44(4,30,3)
      COMMON/SRY19/OMEGA,UN,PAS(19),PVS(19),PAR(19),PVR(19)
      COMMON/SRY20/BLOG(19,19),YLOG(19,19)
      COMMON/SRY21/KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/SRY22/II,EFS,EMR,EMY,EKR(4,30,3),EKY(4,30,3)
      COMPLEX II,EFS(4,30,3),EMR(4,30,3),EMY(4,30,3)
C
C   END OF COMMON DECK
C      (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
      DIMENSION SAS(30),SHB(30),HSB(30),XI(20),YI(20)
      DIMENSION FJ(30),VCBS(30)
    1 FORMAT(1H0,7X,*LENGTH BETWEEN PERPENDICULARS = *,F10.5,1X,A6)
    2 FORMAT(22X,*BEAM AT MIDSHIP = *,F10.5,1X,A6)
    3 FORMAT(21X,*DRAFT AT MIDSHIP = *,F10.5,1X,A6)
    4 FORMAT(25X,15HDISPLACEMENT = F10.3,10H LONG TONS)
    5 FORMAT (1H1,15A6,18X,A6,I4)
    6 FORMAT(20X,20HBLOCK COEFFICIENT = F10.5)
    7 FORMAT(6X,*LONGITUDINAL CENTER OF BUOYANCY = *,F10.5,1X,A6,1X,
     X  *AFT OF F.P.*)
    8 FORMAT(6X,34HLONGITUDINAL CENTER OF BUOYANCY = F10.5,9H STATIONS)
    9 FORMAT(5X,*LONGITUDINAL CENTER OF FLOTATION = *,F10.5,1X,A6,
     X  * AFT OF F.P.*)
   10 FORMAT(5X,35HLONGITUDINAL CENTER OF FLOTATION = F10.5,9H STATIONS)
   11 FORMAT(10X,*VERTICAL CENTER OF BUOYANCY = *,F10.5,1X,A6,
     X  * FROM THE DESIGNED LOAD WATERLINE*)
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   11 FORMAT(12X,28HRADIUS OF GYRATION/L.B.P. = F10.5)
   12 FORMAT(44H0 STATION      BEAM     DRAFT AREA COEFFICIENT)
   13 FORMAT(4F9.4)
   14 FORMAT(6X,10HSTATION = F9.4,6X,30HAREA COEFFICIENT CHANGED FROM F1
     10.4,2X,2HTO,2X,F10.4)
   15 FORMAT(1H0)
   69 FORMAT(13X,27HGIVEN CENTER OF BUOYANCY = F10.5,9H STATIONS)
   90 FORMAT(3F9.4,E15.8)
   92 FORMAT(1H0,5X,30HMINIMUM CRITICAL ENC. FREQ. = F8.4,16H DUE TO STA
     1TION F7.4)
  206 FORMAT(1H0,30X,23H***DATA FOR ONE HULL***)
 300  FORMAT(27X,13HBEAM/DRAFT = F10.5)
 301  FORMAT(26X,14HLENGTH/BEAM = F10.5)
   66 FORMAT(1H0,5X,41HTHE HEAVE-HEAVE RESTORING COEFFICIENT IS F10.5/6X
     1,41HTHE HEAVE-PITCH RESTORING COEFFICIENT IS F10.5/6X,41HTHE PITCH
     2-PITCH RESTORING COEFFICIENT IS F10.5)
193   FORMAT(6X,32HCRITICAL ENC. FREQ. FOR STATION ,F7.4,3H = F8.4)
      UNITS=6HFEET
      IF(GRAV.LT.32.) UNITS=6HMETERS
      FST=EL/20.
      GYR=GYR*GYR
      GYRT=GYRT*GYRT
      VCG=VCG/EL
      GMT=GMT/EL
      DO 16 K=1,NOS
      IF(IN(K).GT.0) GO TO 17
      SQAR(K)=AREA(K)*BEAM(K)*DRFT(K)
      VCBS(K)=0.
      GO TO 20
   17 NUT=IN(K)
      VCBS(K)=0.
      VCBA=0.
      VCBB=0.
      DO 18 J=1,NUT
      YI(J)=Y(K,J)
   18 XI(J)=X(K,J) + SD(1)
      YSML=XMIN(NUT,YI)
      DO 190 IJI=1,NUT
      NNN=IJI
      IF(YSML.EQ.YI(IJI)) GO TO 191
  190 CONTINUE
  191 IJI=NNN
      IF(MONO .GT. 1) GO TO 199
      IJ=IJI-1
      DO 122 J=1,IJ
  122 VCBA=VCBA+ABS((X(K,J)+X(K,J+1))*(Y(K,J)**2-Y(K,J+1)**2))*0.25
      SQER=SIMPUN(YI,XI,IJI)
      SQER=ABS(SQER)
      DO 195 JJJ=IJI,NUT
      IF(JJJ.EQ.NUT) GO TO 127
      VCBB=VCBB+ABS((X(K,JJJ)+X(K,JJJ+1))*(Y(K,JJJ)**2-Y(K,JJJ+1)**2))*
     *0.25
  127 CONTINUE
      KKK=JJJ-IJI+1
      XI(KKK)=XI(JJJ)
```

```
195 YI(KKK)=YI(JJJ)
    SQER2=SIMPUN(YI,XI,KKK)
    IF(MONO-1)56,57,199
 56 SQAR(K)=ABS(SQER2)-SQER
    VCBS(K)=VCBS(K)+VCBB+VCBA
    GO TO 55
 57 SQAR(K)=SQER + SQER2
    IF(X(K,1) .LE. 0. .AND. X(K,NUT) .LE. 0.) GO TO 59
    VCBS(K)=VCBS(K)+VCBB+VCBA
    GO TO 55
 59 VCBS(K)=VCBS(K)+VCBA-VCBB
    GO TO 55
199 SQER=SIMPUN(YI,XI,NUT)
    SQAR(K)=2.*ABS(SQER)
    NAT=NUT-1
    DO 125 J=1,NAT
125 VCBS(K) =VCBS(K)+0.25*ABS((X(K,J)+X(K,J+1))*(Y(K,J)**2-Y(K,J+1)**
   12))
    VCBS(K)=2.*VCBS(K)
 55 DO 196 J=1,NUT
    YI(J)=Y(K,J)
196 XI(J)=X(K,J)
    BEAM(K)=XI(NUT)-XI(1)
    IF(MONO.GT.1) BEAM(K) = 2.*BEAM(K)
    IF(BEAM(K).NE.0.0) GO TO 600
    AREA(K)=SQAR(K)/DRFT(K)**2
    X(K,1)=X(K,1)-0.001
    XI(1)=X(K,1)
     GO TO 20
600   AREA(K)=SQAR(K)/(BEAM(K)*DRFT(K))
 20 SS(K)=FST*ST(K)
 16 SAS(K)=SS(K)*SQAR(K)
    KPK=0
    LSD=0
    IF(NIX.GT.0) GO TO 21
    DO 32 K=1,NOS
    IF(NM(K).GT.0) GO TO 32
    IF((BEAM(K).LE.0.).OR.(DRFT(K).LE.0.)) GO TO 32
    AIR=AREA(K)
    RAT=0.5*BEAM(K)/DRFT(K)
    TAR=1.0/RAT
    IF(RAT.LE.1.0) GO TO 33
    BL=0.29456*(2.0-TAR)
    GO TO 34
 33 BL=0.29456*(2.0-RAT)
 34 UL=0.098125*(RAT+TAR+10.0)
    IF(AREA(K).GT.BL) GO TO 35
    AREA(K)=BL+0.0001
    GO TO 36
 35 IF(AREA(K).LT.UL) GO TO 32
    AREA(K)=UL-0.0001
 36 IF(KPK.GT.0) GO TO 37
    KPK=KPK+1
    NPAG=NPAG+1
    WRITE(6,5)  (PATT(I),I=1,7),(TITLE(J),J=1,8),PATT(8),NPAG
```

```
      WRITE(6,15)
   37 WRITE(6,14)ST(K),AIR,AREA(K)
      LSD=LSD+1
      SQAR(K)=AREA(K)*BEAM(K)*DRFT(K)
      SAS(K)=SS(K)*SQAR(K)
   32 CONTINUE
   21 IF(NUX.LE.0) GO TO 25
      IF(KPK.GT.0) GO TO 93
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,7),(TITLE(J),J=1,8),PATT(8),NPAG
   93 WRITE(6,12)
      DO 22 K=1,NOS
      IF(IN(K).LE.0) GO TO 22
      LSD=LSD+1
      IF(AREA(K).LT.1000.0) GO TO 91
      WRITE(6,90)ST(K),BEAM(K),DRFT(K),AREA(K)
      GO TO 22
   91 WRITE(6,13)ST(K),BEAM(K),DRFT(K),AREA(K)
   22 CONTINUE
      IF(NIX.LE.0) GO TO 25
      OX=100.0
      IF(LSD.LT.23) GO TO 201
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,7),(TITLE(J),J=1,8),PATT(8),NPAG
201   WRITE(6,15)
      DO 23 K=1,NOS
      IF(NM(K).LE.0) GO TO 23
       IF (BEAM(K) .NE. 0.0) GO TO 601
       FJ(K) = 0.0
       GO TO 602
  601  CONTINUE
      A=3.1415927*DRFT(K)/BEAM(K)
      A=A/TANH(A)
      FJ(K)=SQRT(A*EL/DRFT(K))
  602  CONTINUE
      IF(FJ(K).GT.OX) GO TO 233
      OX=FJ(K)
      JOHN=K
  233 WRITE(6,193)ST(K),FJ(K)
   23 CONTINUE
      WRITE(6,92)OX,ST(JOHN)
   25 CONTINUE
      VOL=SIMPUN(SS,SQAR,NOS)
       IF(BEAM(MS).EQ.0.0) GO TO 703
      BLOCK=VOL/(EL*BEAM(MS)*DRFT(MS))
       GO TO 704
 703  BLOCK=0.0
 704  CONTINUE
      VCB=SIMPUN(SS,VCBS,NOS)/VOL
      BOY=SIMPUN(SS,SAS,NOS)/VOL
      CBL=BOY/FST
      IF(GCB.LE.0.0) GO TO 68
      BOY=FST*GCB
   68 DO 19 K=1,NOS
      SHB(K)=(SS(K)-BOY)*BEAM(K)
```

```
   19 HSB(K)=(SS(K)-BOY)*SHB(K)
      EL2=EL*EL
      AMP1=SIMPUN(SS,BEAM,NOS)/EL2
      AMP2=SIMPUN(SS,HSB,NOS)/(EL2*EL2)
      CON=EL2*EL/VOL
      RF33=CON*AMP1
      BG=ABS(VCG*EL+VCB)
      RM55=CON*AMP2-BG/EL
      RP35=SIMPUN(SS,SHB,NOS)/VOL
      GMTS=0.
      IF(ABS(GMT).GT.1.E-04) GO TO 403
      DO 402 K=1,NOS
  402 SHB(K)=BEAM(K)**3
      GMTS=SIMPUN(SS,SHB,NOS)/(12.*EL*VOL)-BG/EL
  403 CFL=BOY+EL*RP35/RF33
      FLC=CFL/FST
      PST=FST*CBL
      FACT=35.89744
      IF(GRAV.LT.32.) FACT=.02832*FACT
      VOL=VOL/FACT
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,7),(TITLE(J),J=1,8),PATT(8),NPAG
      WRITE(6,206)
      WRITE(6,1) EL,UNITS
      WRITE(6,2) BEAM(MS),UNITS
      WRITE(6,3) DRFT(MS),UNITS
      WRITE(6,4)VOL
      VOL=VOL*FACT/EL**3
      WRITE(6,6)BLOCK
      WRITE(6,7) PST,UNITS
      WRITE(6,8)CBL
      IF(GCB.LE.0.0) GO TO 67
      WRITE(6,69)GCB
      PST=FST*GCB
   67 WRITE(6,9) CFL,UNITS
      WRITE(6,10)FLC
      WRITE(6,111) VCB,UNITS
      BDR=BEAM(MS)/DRFT(MS)
      WRITE(6,300)BDR
      IF(BEAM(MS).EQ.0.0) GO TO 700
      ELBR=EL/BEAM(MS)
      GO TO 701
700   ELBR=0.0
701   CONTINUE
      WRITE(6,301)ELBR
      WRITE(6,66) RF33,RP35,RM55
      DO 31 K=1,NOS
      SS(K)=SS(K)/EL
      SQAR(K)=SQAR(K)/EL**2
      BEAM(K)=BEAM(K)/EL
      DRFT(K)=DRFT(K)/EL
      IF(NM(K).LE.0) GO TO 31
      NUT=IN(K)
      DO 24 J=1,NUT
      X(K,J)=X(K,J)/EL
```

```
   24 Y(K,J)=Y(K,J)/EL
   31 CONTINUE
      PST=PST/EL
      CALL NILS(NOS,MS,ST,DS,JFK)
      IF(JFK.GT.0) GO TO 76
      ID=-1
      GO TO 77
   76 IF(OMIN.LE.0.0.OR.JA.EQ.3) GO TO 77
C
C     TRANSFER TO LOOP TO CALL PGM2 AND PGM3
C
      CALL AETSKC(5LPGM1A)
C
 77   CONTINUE
      IF(ID.EQ.2 .OR. ID.EQ.-1) CALL AETSKC(6LMOT246)
      CALL AETSKC(4LPGM4)
      END
```

```
      OVERLAY(3,0)
      PROGRAM PGM1B
C
C
C
      COMMON/SRY1/ NPAG,TITLE(8),PATT(8),RATIO
      COMMON/SRY2/ ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/SRY3/ NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X             DMA(30),AVDA(30),AVBM(30),ST(30),IN(30),SQAR(30),
     X             X(30,20),Y(30,20)
      COMMON/SRY4/ NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/SRY5/ VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/SRY6/ NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/SRY7/ NFN,NFNS,FN(6),FNS(6)
      COMMON/SRY8/ NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/SRY9/ NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/SRY10/XZHB,XZPB,XZFO,XZVL,KV,KW
      COMMON/SRY11/CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/SRY12/CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/SRY13/GRAV,DEPCAT,SD(6),RBMST(10),RBMHT(10)
      COMMON/SRY14/EL,GCB,GYR,GYRT,GM,GMT,GMTS,VCG,RF33,RP35,RM55
      COMMON/SRY15/A26(4,30),A62(4,30),A46(4,30),A64(4,30),A66(4,30)
      COMMON/SRY16/A22(30),A44(30),A24(30),DSR(30),DRR(30)
      COMMON/SRY17/ASY(30),DSY(4,30),AY(30),DY(4,30),ARY(30),DRY(30)
      COMMON/SRY18/B22(4,30),B26(4,30),B62(4,30),B46(4,30),B64(4,30),
     X             B66(4,30),B24(4,30),B44(4,30,3)
      COMMON/SRY19/OMEGA,UN,PAS(19),PVS(19),PAR(19),PVR(19)
      COMMON/SRY20/BLOG(19,19),YLOG(19,19)
      COMMON/SRY21/KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/SRY22/II,EFS,EMR,EMY,EKR(4,30,3),EKY(4,30,3)
      COMPLEX II,EFS(4,30,3),EMR(4,30,3),EMY(4,30,3)
C
C    END OF COMMON DECK
C       (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
      COMPLEX TEMP
      TWODL=2./EL
      CON=1.688
      IF(GRAV.LT.32.) CON=.3048*CON
      CON=SQRT(GRAV*EL)/CON
      FACT=SQRT(GRAV/EL)
      FARD=0.017453293
      BSD=BEAM(MS)*EL
      DO 205 ISD=1,NSD
      HHS=2.0*(SD(ISD))-BSD
      IF(BSD .LE. 1.E-07) GO TO 88
      RATIO=HHS/BSD
      GO TO 87
   88 RATIO=HHS
   87 IF(MONO .GE. 1) RATIO=0.
```

```
      SDI=SD(ISD)/EL
      SD(ISD)=SDI
      IF(ABS(GMTS).GT.1.E-04) GMT=GMTS+SDI*SDI*AMP1/VOL
      IF(GMTS.GT.1.E-04) WRITE(6,176) SD(ISD),GMT
      IF(ISD.GT.1) FAY=FAY+EL*(SD(ISD)-SD(ISD-1))
      IF(ISD.GT.1) FBY=FBY+EL*(SD(ISD)-SD(ISD-1))
      CALL AETSKC(5LQPGM2)
      IF(ID.GT.1) GO TO 77
      CALL AETSKC(6LQPGM2B)
      IF(ID.GT.1) GO TO 77
      CALL AETSKC(5LQPGM3)
      IF(NOW.GT.0) GO TO 78
    5 FORMAT(1H1,15A6,18X,A6,I4)
  171 FORMAT(3X,*WAVE HEADING =*,F6.1,* DEGREES*/)
  172 FORMAT(3X,*ABSOLUTE DISPLACEMENT, VELOCITY, AND *,
     X  *ACCELERATION AT STATION *,F5.1,* AND HEIGHT *,F5.1)
  173 FORMAT(//3X,*SPEED =*,F5.1,* KNOTS*)
  174 FORMAT((5X,F10.2,3(7X,F8.3),5X,F10.4))
  175 FORMAT(3X,*ENC PER(SEC)*,6X,*ABS DISPL*,12X,*VEL*,8X,
     X  *ACCEL/G*,7X,*WAVE L/L*)
  176 FORMAT(////10X,*CALCULATED GMT = *,E12.5,* FOR SEPARATION *
     X  *DISTANCE OF *,F7.2)
      DO 150 KI=1,NSTR
      LINES=2
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,7),(TITLE(I),I=1,8),PATT(8),NPAG
      RBMSTK=RBMST(KI)
      RBMHTK=RBMHT(KI)
      WRITE(6,172) RBMSTK,RBMHTK
      ARM=EL*(PST-.05*RBMSTK)
      DO 150 MM=1,NBTA
      DO 160 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 160
      SPID=FN(JJ)*CON
      LINES=LINES+LMT+5
      IF(LINES.LE.60) GO TO 89
      LINES=5
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,7),(TITLE(I),I=1,8),PATT(8),NPAG
      WRITE(6,172) RBMSTK,RBMHTK
   89 WRITE(6,173) SPID
      WRITE(6,171) WANG(MM)
      WRITE(6,175)
      DO 170 N=1,LMT
      TEMP=EFS(JJ,N,MM)
      SWAY=REAL(TEMP)
      DELTA=FARD*AIMAG(TEMP)
      TEMP=EMY(JJ,N,MM)
      YAW=TWODL*REAL(TEMP)
      EPSIL=FARD*AIMAG(TEMP)
      TEMP=EMR(JJ,N,MM)
      ROLL=REAL(TEMP)
      RPHASE=FARD*AIMAG(TEMP)
```

```
      ABMA=SWAY*COS(DELTA)+ARM*YAW*COS(EPSIL)-RBMHTK*ROLL*COS(RPHASE)
      ABMB=SWAY*SIN(DELTA)+ARM*YAW*SIN(EPSIL)-RBMHTK*ROLL*SIN(RPHASE)
      ABMO=SQRT(ABMA*ABMA+ABMB*ABMB)
      OMEGAE=OMEN(N)*FACT
      ENCP=6.2831853/OMEGAE
      VEL=OMEGAE*ABMO
      ACCEL=OMEGAE*VEL/GRAV
  170 WRITE(6,174) ENCP,ABMO,VEL,ACCEL,RWS(JJ,N,MM)
  160 CONTINUE
  150 CONTINUE
      ID=1
 77   CONTINUE
      IF(IND.EQ.0) GO TO 78
      DO 81 JJ=1,NFN
      DO 81 N=1,NFR
      DO 81 MM=1,NBTA
      EMR(JJ,N,MM)=EKR(JJ,N,MM)+II*AIMAG(EMR(JJ,N,MM))
   81 EMY(JJ,N,MM)=EKY(JJ,N,MM)+II*AIMAG(EMY(JJ,N,MM))
      WRITE(23) NFN,NFR,NBTA
      WRITE(23) (FN(I),I=1,NFN),(OMEN(I),I=1,NFR),(WANG(I),I=1,NBTA)
      WRITE(23) (((WFR(JJ,N,MM),EFS(JJ,N,MM),EMR(JJ,N,MM),EMY(JJ,N,MM),
     X  JJ=1,NFN),N=1,NFR),MM=1,NBTA)
   78 CONTINUE
      IF(JA.EQ.2) CALL AETSKC(5LPGM1A)
      IF(ID.EQ.2 .OR. ID.EQ.-1) CALL AETSKC(6LMOT246)
      IF(LP.EQ.0 .AND. IP.EQ.0 .AND. NOW.EQ.0) CALL AETSKC(6LMOT246)
      IF(LP.EQ.0 .AND. IP.EQ.0) CALL AETSKC(4LPGM5)
  205 CONTINUE
      END
```

```
      PROGRAM QPGM2
C
C
      COMMON/SRY1/ NPAG,TITLE(8),PATT(8),RATIO
      COMMON/SRY2/ ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/SRY3/ NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X             DMA(30),AVDA(30),AVBM(30),ST(30),IN(30),SQAR(30),
     X             X(30,20),Y(30,20)
      COMMON/SRY4/ NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/SRY5/ VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/SRY6/ NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/SRY7/ NFN,NFNS,FN(6),FNS(6)
      COMMON/SRY8/ NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/SRY9/ NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/SRY10/XZHB,XZPB,XZFO,XZVL,KV,KW
      COMMON/SRY11/CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/SRY12/CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/SRY13/GRAV,DEPCAT,SD(6),RBMST(10),RBMHT(10)
      COMMON/SRY14/EL,GCB,GYR,GYRT,GM,GMT,GMTS,VCG,RF33,RP35,RM55
      COMMON/SRY15/A26(4,30),A62(4,30),A46(4,30),A64(4,30),A66(4,30)
      COMMON/SRY16/A22(30),A44(30),A24(30),DSR(30),DRR(30)
      COMMON/SRY17/ASY(30),DSY(4,30),AY(30),DY(4,30),ARY(30),DRY(30)
      COMMON/SRY18/B22(4,30),B26(4,30),B62(4,30),B46(4,30),B64(4,30),
     X             B66(4,30),B24(4,30),B44(4,30,3)
      COMMON/SRY19/OMEGA,UN,PAS(19),PVS(19),PAR(19),PVR(19)
      COMMON/SRY20/BLOG(19,19),YLOG(19,19)
      COMMON/SRY21/KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/SRY22/II,EFS,EMR,EMY,EKR(4,30,3),EKY(4,30,3)
      COMPLEX II,EFS(4,30,3),EMR(4,30,3),EMY(4,30,3)
C
C    END OF COMMON DECK
C       (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
    1 FORMAT(1H0,5X,*DYNAMIC COEFFICIENTS OF THE EQUATIONS OF MOTION*
     X  ////6X,*A22 IS SCALED BY M.*//
     X   6X,*A24, A26 AND A62 ARE SCALED BY *,4HM*L.//
     X   6X,*A44, A46, A64 AND A66 ARE SCALED BY *,6HM*L*L.//
     X   6X,*B22 IS SCALED BY *,12HM*SQRT(G/L).//
     X   6X,*B24, B26 AND B62 ARE SCALED BY *,12HM*SQRT(G*L).//
     X   6X,*B44, B46, B64, AND B66 ARE SCALED BY *,14HM*L*SQRT(G*L).//
     X   6X,4HB44*,* IS B44 EXCLUDING CROSS-FLOW DRAG CONTRIBUTIONS.*//
     X   6X,*M IS THE DISPLACED MASS.*//
     X   6X,*G IS THE ACCELERATION DUE TO GRAVITY.*//
     X   6X,*L IS THE DISTANCE BETWEEN PERPENDICULARS.*////
     X   6X,*FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT(G*,4H*L).//
     X   6X,*BETA IS THE WAVE HEADING ANGLE IN DEGREES.*/
     X   6X,*BETA = 180. FOR HEAD SEAS.*//
     X   6X,*OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED*
     X   * BY SQRT(G/L).*//
     X   6X,*THE HULL SEPARATION/BEAM RATIO IS THE DISTANCE*/
     X   6X,*BETWEEN THE HULLS DIVIDED BY THE BEAM OF ONE HULL.*)
```

```
  2 FORMAT(1H0,5X,*BARE HULL POTENTIAL FLOW ADDED MASS COEFFICIENTS*/
   X  6X,*FN = *,
   X  F5.3//10X,*OMEGA*,7X,*A22*,3X,*A24=A42*,7X,*A26*,7X,*A62*,7X,
   X  *A44*,7X,*A46*,7X,*A64*,7X,*A66*)
  3 FORMAT(1H0,5X,*BARE HULL POTENTIAL FLOW DAMPING COEFFICIENTS*/
   X  6X,*FN = *,F5.3//
   X  10X,*OMEGA*,7X,*B22*,3X,*B24=B42*,7X,*B26*,7X,*B62*,7X,*B44*,
   X  7X,*B46*,7X,*B64*,7X,*B66*)
  4 FORMAT(F15.4,8F10.6)
  5 FORMAT (1H1,15A6,18X,A6,I4)
 11 FORMAT(1H0,5X,8HSTATION,F7.4)
150 FORMAT(1H0,80X,*HULL SEPARATION/BEAM =*,F7.4)
205 FORMAT(1H0,5X,43HPROJECTED AREA OF THE SUBMERGED HULL/L**2 =,E15.6
   1/5X,13HMOMENT/L**3 =,E15.6,5X,24HMOMENT OF INERTIA/L**4 =,E15.6)
    DIMENSION XJK(20)
    COMPLEX F2D,F4D1,F4D2,F6D,ICOSRK,EKD2X,CEKXC
    IF(1.EQ.0) CALL PGM1B
    QPI = 0.7853982
    EL2=EL*EL
    RVOL=VOL*EL*EL2
    NSO=NOS
    II=(0.0,1.0)
    DO 12 MM=1,NBTA
    WAND=WANG(MM)*.01745329252
    COSBET(MM)=COS(WAND)
 12 SINBET(MM)=SIN(WAND)
    CALL QDFCN
    DO 151 JJ=1,NFN
    DO 151 N=1,NFR
    DO 151 MM=1,NBTA
151 RWS(JJ,N,MM)=1./SWR(JJ,N,MM)
    DO 40 N=1,NFR
    A22(N)=0.
    A24(N)=0.
    A44(N)=0.
    DSR(N)=0.
    DRR(N)=0.
    ASY(N)=0.
    AY(N)=0.
    ARY(N)=0.
    DRY(N)=0.
40  CONTINUE
    DO 50 JJ=1,NFN
    DO 50 N=1,NFR
    DSY(JJ,N)=0.
    DY(JJ,N)=0.
    B22(JJ,N)=0.
    DO 50 MM=1,NBTA
    EFS(JJ,N,MM)=(0.,0.)
    EMR(JJ,N,MM)=(0.,0.)
 50 EMY(JJ,N,MM)=(0.,0.)
    SIA=SIM=SII=SIR=SIRM=SIRR=0.
    PROA=PROM=PROI=0.
    DO 60 K=1,NOS
    XIP=PST-SS(K)
```

```
      XIP2=XIP*XIP
      DST=DS(K)
      NUT=NM(K)
      IF(NUT .EQ. 0) GO TO 60
      DO 333 IJK=1,NUT
  333 XJK(IJK)=X(K,IJK)
      XLG=XMAX(NUT,XJK)
      XSM=XMIN(NUT,XJK)
      AVBM(K)=XLG-XSM
      BAM=BEAM(K)
      DRT=DRFT(K)
      AIR=AREA(K)
      DA=DST*AVBM(K)
      PROA=PROA+DA
      PROM=PROM-XIP*DA
      PROI=PROI+XIP2*DA
      NON=NUT-1
      NOE=2*NON
      DO 62 J=1,NUT
      XS(J)=X(K,J)+SD(ISD)
   62 YS(J)=Y(K,J)
      YSML = XMIN(NUT,YS)
      YLG=XMAX(NUT,YS)
      DM=YLG-YSML
      DMA(K)=DM
      AVD=.5*(YLG+YSML)
      AVDA(K)=AVD
      DAB=DST*DM
      SIA=SIA+DAB
      SIM=SIM+DAB*XIP
      SII=SII+DAB*XIP2
C     AVD IS A NEGATIVE NUMBER
      DAB=DAB*AVD
      SIR=SIR-DAB
      SIRM=SIRM-DAB*XIP
      SIRR=SIRR+DAB*AVD
      DO 65  IJI = 1, NUT
      NNN = IJI
      IF(YSML.EQ.YS(IJI)) GO TO 66
   65 CONTINUE
   66 MAXD = NNN
      IF(MONO .GT. 1) MAXD=1
      DO 63 J=1,NON
      XX(J)=0.5*(XS(J)+XS(J+1))
      YY(J)=0.5*(YS(J)+YS(J+1))
      XINT=XS(J+1)-XS(J)
      YINT=YS(J+1)-YS(J)
      DEL(J)=SQRT(XINT**2+YINT**2)
      SNE(J)=YINT/DEL(J)
   63 CSE(J)=XINT/DEL(J)
      CALL FRANK
      IF(ID.LT.2) GO TO 60
      STATION=20.0*SS(K)
      WRITE(6,11)STATION
      GO TO 77
   60 CONTINUE
```

```
      WRITE(6,205) PROA,PROM,PROI
      DO 70 N=1,NFR
      GXI=OMEN(N)
      DEB=GXI*VOL
      DEA=GXI*DEB
      A22(N)=A22(N)/DEA
      A44(N)=A44(N)/DEA
      A24(N)=A24(N)/DEA
      DRR(N)=DRR(N)/DEB
      DSR(N)=DSR(N)/DEB
      ARY(N)=ARY(N)/DEA
      DRY(N)=DRY(N)/DEB
      ASY(N)=ASY(N)/DEA
      AY(N)=AY(N)/DEA
      DO 70 JJ=1,NFN
      DSY(JJ,N)=DSY(JJ,N)/DEB
      DY(JJ,N)=DY(JJ,N)/DEB
      B22(JJ,N)=B22(JJ,N)/DEB
   70 CONTINUE
      DO 71 N=1,NFR
      GXI=OMEN(N)
      GX2=GXI*GXI
      DO 71 JJ=1,NFN
      FNJ=FN(JJ)
      R26=FNJ/GX2
      R66=FNJ*R26
      SA=ASY(N)
      SB=R26*B22(JJ,N)
      A26(JJ,N)=SA+SB
      A62(JJ,N)=SA-SB
      SA=DSY(JJ,N)
      SB=FNJ*A22(N)
      B26(JJ,N)=SA-SB
      B62(JJ,N)=SA+SB
      SA=R26*DSR(N)
      SB=ARY(N)
      A46(JJ,N)=SB+SA
      A64(JJ,N)=SB-SA
      SA=DRY(N)
      SB=FNJ*A24(N)
      B46(JJ,N)=SA-SB
      B64(JJ,N)=SA+SB
      A66(JJ,N)=AY(N)+R66*A22(N)
      B66(JJ,N)=DY(JJ,N)+R66*B22(JJ,N)
   71 CONTINUE
      IF(IG.LT.2) GO TO 306
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,7),(TITLE(J),J=1,8),PATT(8),NPAG
      WRITE(6,150) RATIO
      WRITE(6,1)
      DO 73 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 73
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,7),(TITLE(J),J=1,8),PATT(8),NPAG
```

```
      WRITE(6,150)RATIO
      WRITE(6,2) FN(JJ)
      WRITE(6,4)  (OMEN(N),A22(N),A24(N),A26(JJ,N),A62(JJ,N),A44(N),
     X   A46(JJ,N),A64(JJ,N),A66(JJ,N),N=1,LMT)
      WRITE(6,3) FN(JJ)
      WRITE(6,4)  (OMEN(N),B22(JJ,N),DSR(N),B26(JJ,N),B62(JJ,N),DRR(N),
     X   B46(JJ,N),B64(JJ,N),B66(JJ,N),N=1,LMT)
   73 CONTINUE
  306 CONTINUE
      CSA=CHRDA*SPNA
      CSB=CHRDB*SPNB
      ADFA=QPI*CSA*(CHRDA+THKA)/RVOL
      ADFB=QPI*CSB*(CHRDB+THKB)/RVOL
      FAYEL2=FAY*FAY/EL2
      FBYEL2=FBY*FBY/EL2
      VMAB=(CLFA*FAYEL2*CSA+CLFB*FBYEL2*CSB)/(EL2*VOL)
      AMAB=FAYEL2*ADFA+FBYEL2*ADFB
      SDI=SD(ISD)
      B44SI=PROA*SDI*SDI+SIRR
      HXZVL=.5*XZVL/VOL
      DO 72 N=1,NFR
      GXI=OMEN(N)
      GX2=GXI*GXI
      A44(N)=A44(N)+AMAB
      DO 72 JJ=1,NFN
      FNJ=FN(JJ)
      VISF=HXZVL*FNJ*FNJ/GX2
      A26(JJ,N)=A26(JJ,N)+VISF*SIA
      A46(JJ,N)=A46(JJ,N)+VISF*SIR
      A66(JJ,N)=A66(JJ,N)+VISF*SIM
      VISF=HXZVL*FNJ
      SA=VISF*SIM
      B26(JJ,N)=B26(JJ,N)+SA
      B62(JJ,N)=B62(JJ,N)+SA
      SA=DRR(N)+FNJ*VMAB+VISF*B44SI
      DO 75 MM=1,NBTA
   75 B44(JJ,N,MM)=SA
      B24(JJ,N)=DSR(N)+VISF*SIR
      SA=VISF*SIRM
      B46(JJ,N)=B46(JJ,N)+SA
      B64(JJ,N)=B64(JJ,N)+SA
      B66(JJ,N)=B66(JJ,N)+VISF*SII
   72 B22(JJ,N)=B22(JJ,N)+VISF*SIA
      DEPCAL=DEPCAT/EL
      DO 80 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 80
      HXZVL=.5*FN(JJ)*XZVL
      DO 81 MM=1,NBTA
      COSB=COSBET(MM)
      SSINB=SDI*SINBET(MM)
      DO 81 N=1,LMT
      CAY=WN(JJ,N,MM)
      ICOSBK=II*CAY*COSB
      EKD=EXP(-CAY*DEPCAL)
```

```
      F2D=F4D1=F4D2=F6D=(0.,0.)
      DO 82 K=1,NOS
      XIP=PST-SS(K)
      D=DMA(K)
      D2=-AVDA(K)
      CEKXC=CEXP(ICOSBK*XIP)*DST
      EKD2X=EXP(-CAY*D2)*CEKXC
      F2D=F2D+D*EKD2X
      IF(DEPCAT.LE.0.) EKD=EXP(-CAY*AREA(K)*DPFT(K))
C     DEPCAT DEFINED FOR SWATH
C     AREA(K)*DPFT(K) GIVES (CROSS SECTIONAL AREA)/BEAM
      F4D1=AVBM(K)*EKD*CEKXC
      F4D2=F4D2+D*D2*EKD2X
   82 F6D=F6D+XIP*D*EKD2X
      CON=HXZVL*WFR(JJ,N,MM)
      ARG=CAY*SSINB
      CONC=CON*COS(ARG)
      EFS(JJ,N,MM)=EFS(JJ,N,MM)-CONC*F2D
      EMR(JJ,N,MM)=EMR(JJ,N,MM)-CON*SDI*SIN(ARG)*F4D1-CONC*F4D2
      EMY(JJ,N,MM)=EMY(JJ,N,MM)-CONC*F6D
   81 CONTINUE
   80 CONTINUE
   77 CONTINUE
      CALL AERTRNK
      END
```

```
      PROGRAM QPGM2B
C
C
      COMMON/SRY1/ NPAG,TITLE(8),PATT(8),RATIO
      COMMON/SRY2/ ID,IG,IP,IND,ISO,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/SRY3/ NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X             DMA(30),AVDA(30),AVBM(30),ST(30),IN(30),SQAR(30),
     X             X(30,20),Y(30,20)
      COMMON/SRY4/ NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/SRY5/ VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/SRY6/ NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/SRY7/ NFN,NFNS,FN(6),FNS(6)
      COMMON/SRY8/ NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/SRY9/ NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/SRY10/XZHB,XZPB,XZFO,XZVL,KV,KW
      COMMON/SRY11/CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/SRY12/CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/SRY13/GRAV,DEPCAT,SD(6),RBMST(10),RBMHT(10)
      COMMON/SRY14/EL,GCB,GYR,GYRT,GM,GMT,GMTS,VCG,RF33,RP35,RM55
      COMMON/SRY15/A26(4,30),A62(4,30),A46(4,30),A64(4,30),A66(4,30)
      COMMON/SRY16/A22(30),A44(30),A24(30),DSR(30),DRR(30)
      COMMON/SRY17/ASY(30),DSY(4,30),AY(30),DY(4,30),ARY(30),DRY(30)
      COMMON/SRY18/B22(4,30),B26(4,30),B62(4,30),B46(4,30),B64(4,30),
     X             B66(4,30),B24(4,30),B44(4,30,3)
      COMMON/SRY19/OMEGA,UN,PAS(19),PVS(19),PAR(19),PVR(19)
      COMMON/SRY20/BLOG(19,19),YLOG(19,19)
      COMMON/SRY21/KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/SRY22/II,EFS,EMR,EMY,EKR(4,30,3),EKY(4,30,3)
      COMPLEX II,EFS(4,30,3),EMR(4,30,3),EMY(4,30,3)
C
C    END OF COMMON DECK
C      (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
      DIMENSION DTMA(30)
      COMPLEX  EGS,ENR,ENY,SEMR(4,30,3)
      COMMON /PR23B/ EGS(4,30,3),ENR(4,30,3),ENY(4,30,3)
      COMPLEX CZIR,COSBK,SINBKS,EBKSP,EBKSM,EX,EXPL,EXMN,CZIRS,CZIRH,
     X  F4DMP,TA,CZIS,CZIY,SZIR,IKS,CEXPA,CEXPB,CEXMA,CEXMB,PA,PB,
     X  EKDA,EKDB
    5 FORMAT (1H1,15A6,18X,A6,I4)
    7 FORMAT(F15.4,8F10.6)
    6 FORMAT(1H0,5X,*EXCITING FORCE, MOMENTS AND PHASES*////
     X  6X,*THE SWAY FORCE IS SCALED BY *,6HM*G*A.//
     X  6X,*THE ROLL AND YAW MOMENTS ARE SCALED BY *,6HM*G*A.//
     X  6X,7H*MOMENT,* DENOTES THE MOMENT SCALED BY *,
     X  20HM*G*A*(WAVE NUMBER).//
     X  6X,*M IS THE DISPLACED MASS.*//
     X  6X,*G IS THE ACCELERATION DUE TO GRAVITY.*//
     X  6X,*A IS THE WAVE AMPLITUDE.*//
     X  6X,*L IS THE DISTANCE BETWEEN PERPENDICULARS.*////
```

```
     X   6X,*FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT(G*,4H*L).//
     X   6X,*BETA IS THE WAVE HEADING ANGLE IN DEGREES.*/
     X   6X,*BETA = 180. FOR HEAD SEAS.*//
     X   6X,*OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED*,
     X   * BY SQRT(G/L).*//
     X   6X,*THE PHASE ANGLE IS MEASURED IN DEGREES WITH RESPECT*/
     X   6X,*TO THE WAVE AT THE CG. *//
     X   6X,*L/LAM = L/(WAVE LENGTH).*//
     X 6X,*FOR FOLLOWING SEAS THE FREQUENCY DOMAIN IS DIVIDED INTO*,
     X   * THREE*/6X,*REGIONS SEPARATED BY TWO CRITICAL SWR, DENOTED *,
     X   *CWR1 AND CWR2.*)
   8 FORMAT(1H0,5X,*EXCITING FORCE, MOMENTS AND PHASES*/
     X   6X,*FN = *,F5.3/6X,*BETA = *,F6.1//
     X   * REGION *,I1,* CWR1 = *,F9.4,* CWR2 = *,F9.4/6X,*OMEGA*,5X,
     X   *L/LAM*,4X,*SFORCE*,5X,*PHASE*,3X,*RMOMENT*,5X,*PHASE*,3X,
     X   7H*MOMENT,3X,*YMOMENT*,5X,*PHASE*,3X,7H*MOMENT,5X,*LAM/L*)
   9 FORMAT(1H0,5X,*EXCITING FORCE, MOMENTS AND PHASES*/
     X   6X,*FN = *,F5.3/6X,*BETA = *,F6.1//
     X   6X,*OMEGA*,5X,*L/LAM*,4X,*SFORCE*,5X,*PHASE*,3X,*RMOMENT*,
     X   5X,5HPHASE,3X,7H*MOMENT,3X,7HYMOMENT,5X,5HPHASE,3X,7H*MOMENT,
     X   5X,5HLAM/L)
  10 FORMAT((1X,F10.4,F10.4,F10.5,F10.3,2(F10.5,F10.3,F10.5),F10.4))
  13 FORMAT(1H0,5X,*ADDED MASS COEFFICIENTS*/6X,*FN = *,F5.3//
     X   10X,*OMEGA*,7X,3HA22,3X,7HA24=A42,7X,3HA26,7X,3HA62,7X,3HA44,
     X   4X,3HA46,7X,3HA64,7X,3HA66)
     X   3HA66)
150   FORMAT(1H0,80X,23HHULL SEPARATION/BEAM = F7.4)
 212 FORMAT(1H0,5X,*FN = *,F5.3/6X,*BETA = *,F6.1/10X,
     X   *OMEGA*,6X,*SWAY*,5X,*PHASE*,6X,*ROLL*,5X,*PHASE*,7X,*YAW*,5X,
     X   *PHASE*,5X,*LAM/L*)
 213 FORMAT((5X,F10.3,3(F10.5,F10.3),F10.4))
 214 FORMAT(//6X,*EQUATIONS OF MOTION SOLVED USING B44 EXCLUDING *,
     X   *VISCOUS EFFECTS*)
 215 FORMAT(//6X,*EQUATIONS OF MOTION SOLVED WITH CROSS-FLOW *
     X   *VISCOUS DAMPING AND ROLL WAVE EXCITING MOMENT INCLUDED*)
 410 FORMAT(1H0,5X,*DAMPING COEFFICIENTS*/6X,*FN = *,F5.3//
     X   6X,5HOMEGA,7X,3HB22,3X,7HB24=B42,7X,3HB44,7X,3HB66,7X,3HB26,
     X   7X,3HB62,7X,3HB46,7X,3HB64,6X,4HB44*/35X,6HBETA =/
     X   35X,F6.1/)
 411 FORMAT(1X,F10.4,9F10.6)
 412 FORMAT(1H0,5X,*DAMPING COEFFICIENTS*/6X,*FN = *,F5.3//
     X   6X,5HOMEGA,7X,3HB22,3X,7HB24=B42,2(7X,3HB44),7X,3HB66,7X,3HB26,
     X   7X,3HB62,7X,3HB46,7X,3HB64,6X,4HB44*/31X,2(4X,6HBETA =)/
     X   31X,2(4X,F6.1))
 413 FORMAT(1X,F10.4,10F10.6)
 414 FORMAT(1H0,5X,*DAMPING COEFFICIENTS*/6X,*FN = *,F5.3//
     X   6X,5HOMEGA,7X,3HB22,3X,7HB24=B42,3(7X,3HB44),7X,3HB66,7X,3HB26,
     X   7X,3HB62,7X,3HB46,7X,6HB64,6X,4HB44*/31X,3(4X,6HBETA =)/
     X   31X,3(4X,F6.1))
 415 FORMAT(1X,F10.4,11F10.6)
 500 FORMAT(///5X,*ROLL AMP FAILED TO CONVERGE FOR BETA = *,F6.1,
     X * FN = *,F5.3/6X,*LAST TWO VALUES = *,E12.5,* AND *,E12.5,3H***,
     X   *CALCULATION CONTINUES*)
 501 FORMAT(///5X,*ITERATION NOT USED.  MAX AMP = *,E12.5)
 502 FORMAT(5X,*NUMBER OF ITERATIONS =*,I2)
```

```
      IF(1.EQ.0) CALL PGM1B
      PI=3.14159
      SDI=SD(ISD)
      SD2=SDI*SDI
      RFACT=SDI
      IF(MONO.EQ.2) RFACT=.5*BEAM(MS)
      IF(IG.NE.3) GO TO 29
      KR=0
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,7),(TITLE(I),I=1,8),PATT(8),NPAG
      WRITE(6,150) RATIO
      WRITE(6,214)
      CALL SOLVE(2,VOL,1,NFN,1,NBTA,1,NFR,RFACT)
      DO 28 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 28
      DO 27 MM=1,NBTA
      LM4=LMT+4
      IF(55-KR.GE.LM4) GO TO 26
      KR=0
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,7),(TITLE(I),I=1,8),PATT(8),NPAG
      WRITE(6,150) RATIO
      WRITE(6,214)
   26 WRITE(6,212) FN(JJ),WANG(MM)
      WRITE(6,213) (OMEN(N),EGS(JJ,N,MM),ENR(JJ,N,MM),ENY(JJ,N,MM),
     X  RWS(JJ,N,MM),N=1,LMT)
      KR=KR+LM4
   27 CONTINUE
   28 CONTINUE
   29 CONTINUE
      DO 83 JJ=1,NFN
      DO 83 N=1,NFR
   83 DY(JJ,N)=B44(JJ,N,1)
      ELEL=EL*EL
      FAYEL=FAY/EL
      FBYEL=FBY/EL
      DEPAL=DEPA/EL
      DEPBL=DEPB/EL
      DEPCAL=DEPCAT/EL
      FALP=PST-FAL/EL
      FBLP=PST-FBL/EL
      IF(CLFA.LE.0. .AND. CLFB.LE.0.) GO TO 399
      CONA=.5*SPNA*CHRDA*CLFA*FAYEL/ELEL
      CONB=.5*SPNB*CHRDB*CLFB*FBYEL/ELEL
      DO 80 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 80
      DO 81 MM=1,NBTA
      COSB=COSBET(MM)
      SINB=SINBET(MM)
      DO 81 N=1,LMT
      CAY=WN(JJ,N,MM)
      CAYB=CAY*SINB
```

```
      SYA=SIN(CAYB*FAYEL)
      SYB=SIN(CAYB*FBYEL)
      CAYB=CAY*COSB
      WLA=CAYB*FALP
      WLB=CAYB*FBLP
      CON=WFR(JJ,N,MM)*FN(JJ)
      FEXA=CON*EXP(-CAY*DEPAL)*CONA*SYA
      FEXB=CON*EXP(-CAY*DEPBL)*CONB*SYB
   81 EMR(JJ,N,MM)=EMR(JJ,N,MM)-FEXA*CEXP(II*WLA)-FEXB*CEXP(II*WLB)
   80 CONTINUE
  399 IF(XZFO+XZFA+XZFB.LE.0.) GO TO 73
C     .21221=2/(3*PI)
C     .005=A/EL=EMPIRICAL FACTOR
C     CONT=(.005*EL)*.21221*XZFO/EL
      CONT=.001061*XZFO
      CONS=CONT/VOL
      CON=2./(3.*PI*ELEL*EL)
      CONEA=CON*XZFA*FAYEL*CHRDA*SPNA
      CONEB=CON*XZFB*FBYEL*CHRDB*SPNB
      CONDA=CONEA*FAYEL/VOL
      CONDB=CONEB*FBYEL/VOL
      DO 70 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 70
      DO 71 MM=1,NBTA
      ILOOP=-1
      IF(IG.NE.3) GO TO 78
      KR=0
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,7),(TITLE(I),I=1,8),PATT(8),NPAG
      WRITE(6,150) RATIO
      WRITE(6,215)
      LM4=LMT+4
   78 DO 74 N=1,LMT
   74 SEMR(N)=EMR(JJ,N,MM)
  555 ILOOP=ILOOP+1
      CALL SOLVE(2,VOL,JJ,JJ,MM,MM,1,LMT,RFACT)
      IF(IG.NE.3) GO TO 82
      IF(55-KR.GE.LM4) GO TO 79
      KR=0
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,7),(TITLE(I),I=1,8),PATT(8),NPAG
      WRITE(6,150) RATIO
      WRITE(6,215)
   79 WRITE(6,212) FN(JJ),WANG(MM)
      WRITE(6,213) (OMEN(N),EGS(JJ,N,MM),ENR(JJ,N,MM),ENY(JJ,N,MM),
     X  RWS(JJ,N,MM),N=1,NFR)
      KR=KR+LM4
   82 IF(NLOOP.LE.0) GO TO 21
      DO 54 N=1,LMT
   54 DTMA(N)=REAL(ENR(JJ,N,MM))
      ENRMXL=ENRMX
      ENRMX=XMAX(LMT,DTMA)
      IF(ENRMX.GT..01) GO TO 556
      WRITE(6,501) ENRMX
```

```
      ILOOP=NLOOP
      GO TO 21
  556 IF(ILOOP.LE.0) GO TO 21
      IF(ABS(1.-ENRMX/ENRMXL).LE..1) GO TO 71
C   COMPUTE CROSS-FLOW VISCOUS DAMPING AND WAVE-EXCITING MOMENT
C
   21 DO 75 N=1,LMT
      GXI=OMEN(N)
      CAY=WN(JJ,N,MM)
      OMEG=WFR(JJ,N,MM)
      WDW=OMEG/GXI
      WW=OMEG*GXI
      COSB=COSBET(MM)
      SINB=SINBET(MM)
      EKD=EXP(-CAY*DEPCAL)
      EKDW=WDW*EKD
      COSBK=II*CAY*COSB
      SINBKS=II*SDI*CAY*SINB
      EBKSP=CEXP(SINBKS)
      EBKSM=CEXP(-SINBKS)
      TA=EGS(JJ,N,MM)
      ZRS=REAL(TA)
      ZIS=AIMAG(TA)/57.295779
      CZIS=ZRS*CEXP(-II*ZIS)
      TA=ENR(JJ,N,MM)
      ZRR=REAL(TA)
      ZIR=AIMAG(TA)/57.295779
      CZIR=ZRR*CEXP(-II*ZIR)/RFACT
      TA=ENY(JJ,N,MM)
      ZRY=REAL(TA)
      ZIY=AIMAG(TA)/57.295779
      CZIY=ZRY*CEXP(-II*ZIY)
      CZIRS=II*CZIR
      SZIR=SDI*CZIR
      B44DMP=0.
      F4DMP=(0.,0.)
      DO 72 K=1,NOS
      XIP=PST-SS(K)
      D=DMA(K)
      D2=-AVDA(K)
      DD2=D*D2
      AVB=AVBM(K)
      DST=DS(K)
      EX=CEXP(XIP*COSBK)
      EXPL=EX*EBKSP
      EXMN=EX*EBKSM
      IF(DEPCAT.LE.0) EKDW=WDW*EXP(-CAY*AREA(K)*DRFT(K))
      ZRSD=CABS(SZIR+EKDW*EXPL)
      ZRPD=CABS(SZIR-EKDW*EXMN)
      EHX=EXP(-CAY*D2)
      WX=WDW*EHX
      CZIRH=CZIS+XIP*CZIY+D2*CZIR
      Y1SD=CABS(II*CZIRH-WX*EXPL)
      Y1PD=CABS(II*CZIRH-WX*EXMN)
      B44DMP=B44DMP+(SD2*AVB*(ZRSD+ZRPD)+DD2*D2*(Y1SD+Y1PD))*DST
      F4DMP=F4DMP+(II*AVB*SDI*(ZRSD*EXPL-ZRPD*EXMN)-
     X  DD2*(Y1SD*EXPL+Y1PD*EXMN))*DST
```

```
72 CONTINUE
   EKDA=EXP(-CAY*DEPAL)*CEXP(COSBK*FALP)
   EKDB=EXP(-CAY*DEPBL)*CEXP(COSBK*FBLP)
   C1=WDW*EKDA
   C2=WDW*EKDB
   IKS=II*CAY*SINB
   PA=IKS*FAYEL
   PB=IKS*FBYEL
   CEXPA=CEXP(PA)
   CEXMA=CEXP(-PA)
   CEXPB=CEXP(PB)
   CEXMB=CEXP(-PB)
   ZSORDA=CABS(FAYEL*CZIR+C1*CEXPA)
   ZPORDA=CABS(FAYEL*CZIR-C1*CEXMA)
   ZSORDB=CABS(FBYEL*CZIR+C2*CEXPB)
   ZPORDB=CABS(FBYEL*CZIR-C2*CEXMB)
   B44(JJ,N,MM)=DY(JJ,N)+CONS*GXI*B44DMP+GXI*(CONDA*(ZSORDA+ZPORDA)
  X   +CONDB*(ZSORDB+ZPORDB))
   EMR(JJ,N,MM)=SEMR(N)+WW*CONT*EKD*F4DMP+II*WW*CONEA*EKDA*
  X   (ZSORDA*CEXPA-ZPORDA*CEXMA)+II*WW*CONEB*EKDB*(ZSORDB*CEXPB-
  X   ZPORDB*CEXMB)
75 CONTINUE
   IF(NLOOP.GT.ILOOP) GO TO 555
   WRITE(6,500) WANG(MM),FN(JJ),ENRMXL,ENRMX
71 CONTINUE
70 CONTINUE
73 DO 85 JJ=1,NFN
   LMT=MIL(JJ)
   IF(LMT.LE.0) GO TO 85
   DO 84 MM=1,NBTA
   DO 84 N=1,LMT
   EFS(JJ,N,MM)=EFS(JJ,N,MM)/VOL
   EMR(JJ,N,MM)=EMR(JJ,N,MM)/VOL
   EMY(JJ,N,MM)=EMY(JJ,N,MM)/VOL
   ZRS=CABS(EFS(JJ,N,MM))
   ZRR=CABS(EMR(JJ,N,MM))
   ZRY=CABS(EMY(JJ,N,MM))
   ZIS=0.
   IF(ZRS.GT.0.)
  X    ZIS=-57.295779*ATAN2(AIMAG(EFS(JJ,N,MM)),REAL(EFS(JJ,N,MM)))
   IF(ZIS.GT.90.) ZIS=ZIS-360.
   ZIR=0.
   IF(ZRR.GT.0.)
  X  ZIR=-57.295779*ATAN2(AIMAG(EMR(JJ,N,MM)),REAL(EMR(JJ,N,MM)))
   IF(ZIR.LT.-270.) ZIR=ZIR+360.
   ZIY=0.
   IF(ZRY.GT.0.)
  X  ZIY=-57.295779*ATAN2(AIMAG(EMY(JJ,N,MM)),REAL(EMY(JJ,N,MM)))
   IF(ZIY.LT.-270.) ZIY=ZIY+360.
   EGS(JJ,N,MM)=CMPLX(ZRS,ZIS)
   ENR(JJ,N,MM)=CMPLX(ZRR,ZIR)
   ENY(JJ,N,MM)=CMPLX(ZRY,ZIY)
   CAY=WN(JJ,N,MM)
   EKR(JJ,N,MM)=ZRR/CAY
   EKY(JJ,N,MM)=ZRY/CAY
84 CONTINUE
85 CONTINUE
```

```
      IF(IG.LE.0) GO TO 77
      IF(IG.EQ.1) GO TO 111
      DO 95 JJ=1,NFN
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,7),(TITLE(I),I=1,8),PATT(8),NPAG
      WRITE(6,150) RATIO
      WRITE(6,13) FN(JJ)
      WRITE(6,7) (OMEN(N),A22(N),A24(N),A26(JJ,N),A62(JJ,N),A44(N),
     X  A46(JJ,N),A64(JJ,N),A66(JJ,N),N=1,NFR)
      GO TO(401,402,403) NBTA
  401 WRITE(6,410) FN(JJ),WANG(1)
      WRITE(6,411) (OMEN(N),B22(JJ,N),B24(JJ,N),B44(JJ,N,1),
     X  B66(JJ,N),B26(JJ,N),B62(JJ,N),B46(JJ,N),B64(JJ,N),DY(JJ,N),
     X  N=1,NFR)
      GO TO 404
  402 WRITE(6,412) FN(JJ),WANG(1),WANG(2)
      WRITE(6,413) (OMEN(N),B22(JJ,N),B24(JJ,N),(B44(JJ,N,I),I=1,2),
     X  B66(JJ,N),B26(JJ,N),B62(JJ,N),B46(JJ,N),B64(JJ,N),DY(JJ,N),
     X  N=1,NFR)
      GO TO 404
  403 WRITE(6,414) FN(JJ),(WANG(I),I=1,3)
      WRITE(6,415) (OMEN(N),B22(JJ,N),B24(JJ,N),(B44(JJ,N,I),I=1,3),
     X  B66(JJ,N),B26(JJ,N),B62(JJ,N),B46(JJ,N),B64(JJ,N),DY(JJ,N),
     X  N=1,NFR)
  404 CONTINUE
   95 CONTINUE
  111 NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,7),(TITLE(J),J=1,8),PATT(8),NPAG
      WRITE(6,150) RATIO
      WRITE(6,6)
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,7),(TITLE(J),J=1,8),PATT(8),NPAG
      WRITE(6,150) RATIO
      KR=0
      DO 104 MM=1,NBTA
      DO 100 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 100
      LM4=LMT+4
      IF(55-KR.GE.LM4) GO TO 103
      KR=0
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,7),(TITLE(J),J=1,8),PATT(8),NPAG
      WRITE(6,150) RATIO
  103 IF(KASE(JJ).EQ.0) GO TO 101
      WRITE(6,8) FN(JJ),WANG(MM),KASE(JJ),CWR1(JJ),CWR2(JJ)
      GO TO 102
  101 WRITE(6,9) FN(JJ),WANG(MM)
  102 WRITE(6,10) (OMEN(N),SWR(JJ,N,MM),EGS(JJ,N,MM),ENR(JJ,N,MM),
     X EKR(JJ,N,MM),ENY(JJ,N,MM),EKY(JJ,N,MM),RWS(JJ,N,MM),N=1,LMT)
      KR=KR+LM4
  100 CONTINUE
  104 CONTINUE
   77 CONTINUE
      CALL AERTRNK
      END
```

```
      PROGRAM QPGM3
C
C
      COMMON/SRY1/ NPAG,TITLE(8),PATT(8),RATIO
      COMMON/SRY2/ ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/SRY3/ NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X             DMA(30),AVDA(30),AVBM(30),ST(30),IN(30),SQAR(30),
     X             X(30,20),Y(30,20)
      COMMON/SRY4/ NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/SRY5/ VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/SRY6/ NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/SRY7/ NFN,NFNS,FN(6),FNS(6)
      COMMON/SRY8/ NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/SRY9/ NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/SRY10/XZHB,XZPB,XZFO,XZVL,KV,KW
      COMMON/SRY11/CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/SRY12/CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/SRY13/GRAV,DEPCAT,SD(6),RBMST(10),RBMHT(10)
      COMMON/SRY14/EL,GCB,GYR,GYRT,GM,GMT,GMTS,VCG,RF33,RP35,RM55
      COMMON/SRY15/A26(4,30),A62(4,30),A46(4,30),A64(4,30),A66(4,30)
      COMMON/SRY16/A22(30),A44(30),A24(30),DSR(30),DRR(30)
      COMMON/SRY17/ASY(30),DSY(4,30),AY(30),DY(4,30),ARY(30),DRY(30)
      COMMON/SRY18/B22(4,30),B26(4,30),B62(4,30),B46(4,30),B64(4,30),
     X             B66(4,30),B24(4,30),B44(4,30,3)
      COMMON/SRY19/OMEGA,UN,PAS(19),PVS(19),PAR(19),PVR(19)
      COMMON/SRY20/BLOG(19,19),YLOG(19,19)
      COMMON/SRY21/KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/SRY22/II,EFS,EMR,EMY,EKR(4,30,3),EKY(4,30,3)
      COMPLEX II,EFS(4,30,3),EMR(4,30,3),EMY(4,30,3)
C
C    END OF COMMON DECK
C       (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
      COMPLEX EGS,ENR,ENY
      COMMON /PR23B/ EGS(4,30,3),ENR(4,30,3),ENY(4,30,3)
    1 FORMAT(1H0,5X,*MOTION AMPLITUDES AND PHASES*////
     X  6X,*THE SWAY AMPLITUDE IS SCALED BY A.*//
     X  6X,*THE ROLL AMPLITUDE IS SCALED BY *,6H2*A/B.//
     X  6X,*THE YAW AMPLITUDE IS SCALED BY *,6H2*A/L.//
     X  6X,5H*ROLL,* DENOTES ROLL AMPLITUDE SCALED BY *,
     X  4H  A*,*(WAVE NUMBER).*//
     X  6X,4H*YAW,* DENOTES YAW AMPLITUDE SCALED BY *,
     X  16HA*(WAVE NUMBER).//
     X  6X,*A IS THE WAVE AMPLITUDE.*//
     X  6X,*B IS THE TOTAL HULL SEPARATION FOR TWIN-HULL SHIPS.*//
     X  6X,*B IS THE BEAM AT MIDSHIP FOR MONO-HULL SHIPS.*//
     X  6X,*L IS THE DISTANCE BETWEEN PERPENDICULARS.*////
     X  6X,*FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT(G*,4H*L)./)
    2 FORMAT(6X,*BETA IS THE WAVE HEADING ANGLE IN DEGREES.*/
     X  6X,*BETA = 180. FOR HEAD SEAS.*//
```

```
      X  6X,*OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED*,
      X  * BY SQRT(G/L).*//
      X  6X,*THE PHASE ANGLE IS MEASURED IN DEGREES WITH RESPECT*
      X  * TO THE WAVE AT THE CG. *//
      X  6X,*L/LAM = L/(WAVE LENGTH).*//
      X  6X,*FOR FOLLOWING SEAS THE FREQUENCY IS DIVIDED INTO THREE*/
      X  6X,*REGIONS SEPARATED BY TWO CRITICAL SWR, DENOTED CWR1 AND *
      X  *CWR2.*)
    5 FORMAT (1H1,15A6,18X,A6,I4)
    8 FORMAT(1H0,5X,28HMOTION AMPLITUDES AND PHASES/6X,
     X  5HFN = ,F5.3/6X,7HBETA = ,F6.1//                                  8
     1H REGION I1,8H CWR1 = F8.4,8H CWR2 = F8.4/6X,5HOMEGA,7X,3HSWR,5X,5
     XH SWAY,5X,5HPHASE,6X,4HROLL,5X,5HPHASE,4X,5H*ROLL,5X,3HYAW,7X,
     X  5HPHASE,5X,4H*YAW,5X,5HLAM/L)
    9 FORMAT(1H0,5X,*MOTION AMPLITUDES AND PHASES*/
     X  6X,*FN = *,F5.3/6X,*BETA = *,F6.1//6X,                           5H
     XOMEGA,5X,5HL/LAM,6X,4HSWAY,5X,5HPHASE,6X,4HROLL,5X,5HPHASE,5X,
     X  5H*ROLL,7X,3HYAW,5X,5HPHASE,6X,4H*YAW,5X,5HLAM/L)
   10 FORMAT((1X,2F10.4,F10.5,F10.3,2(F10.5,F10.3,F10.5),F10.4))
  150 FORMAT(1H0,80X,23HHULL SEPARATION/BEAM = F7.4)
      IF(1.EQ.0) CALL PGM18
      RFACT=SD(ISD)
      IF(MONO.EQ.2) RFACT=.5*BEAM(MS)
      CALL SOLVE(3,1.,1,NFN,1,NBTA,1,NFR,RFACT)
      DO 20 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 20
      DO 30 N=1,LMT
      DO 30 MM=1,NBTA
      EFS(JJ,N,MM)=EGS(JJ,N,MM)
      EMR(JJ,N,MM)=ENR(JJ,N,MM)
      EMY(JJ,N,MM)=ENY(JJ,N,MM)
   30 CONTINUE
   20 CONTINUE
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,7),(TITLE(J),J=1,8),PATT(8),NPAG
      WRITE(6,150)RATIO
      WRITE(6,1)
      WRITE(6,2)
      KR=0
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,7),(TITLE(J),J=1,8),PATT(8),NPAG
      WRITE(6,150)RATIO
      DO 44 MM=1,NBTA
      DO 40 JJ=1,NFN
      LMT=MIL(JJ)
      IF(LMT.LE.0) GO TO 40
      LM4=LMT+4
      IF((55-KR).GE.LM4) GO TO 43
      KR=0
      NPAG=NPAG+1
      WRITE(6,5) (PATT(I),I=1,7),(TITLE(J),J=1,8),PATT(8),NPAG
      WRITE(6,150)RATIO
43    IF(KASE(JJ).EQ.0) GO TO 41
      WRITE(6,8) FN(JJ),WANG(MM),KASE(JJ),CWR1(JJ),CWR2(JJ)
```

```
      GO TO 42
   41 WRITE(6,9) FN(JJ),WANG(MM)
   42 WRITE(6,10)  (OMEN(N),SWR(JJ,N,MM),EFS(JJ,N,MM),EMR(JJ,N,MM),
     X   EKR(JJ,N,MM),EMY(JJ,N,MM),EKY(JJ,N,MM),RWS(JJ,N,MM),N=1,LMT)
      KR=KR+LM4
   40 CONTINUE
   44 CONTINUE
      CALL AERTRN
      END
```

```
      SUBROUTINE SOLVE(IOPT,CON,IFNF,IFNL,IBTAF,IBTAL,IFRF,IFRL,RFACT)
C
C
      COMMON/SRY1/ NPAG,TITLE(8),PATT(8),RATIO
      COMMON/SRY2/ ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/SRY3/ NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X             DMA(30),AVDA(30),AVBM(30),ST(30),IN(30),SQAR(30),
     X             X(30,20),Y(30,20)
      COMMON/SRY4/ NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/SRY5/ VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/SRY6/ NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/SRY7/ NFN,NFNS,FN(6),FNS(6)
      COMMON/SRY8/ NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/SRY9/ NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/SRY10/XZHB,XZPB,XZFO,XZVL,KV,KW
      COMMON/SRY11/CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/SRY12/CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/SRY13/GRAV,DEPCAT,SD(6),RBMST(10),RBMHT(10)
      COMMON/SRY14/EL,GCB,GYR,GYRT,GM,GMT,GMTS,VCG,RF33,RP35,RM55
      COMMON/SRY15/A26(4,30),A62(4,30),A46(4,30),A64(4,30),A66(4,30)
      COMMON/SRY16/A22(30),A44(30),A24(30),DSR(30),DRR(30)
      COMMON/SRY17/ASY(30),DSY(4,30),AY(30),DY(4,30),ARY(30),DRY(30)
      COMMON/SRY18/B22(4,30),B26(4,30),B62(4,30),B46(4,30),B64(4,30),
     X             B66(4,30),B24(4,30),B44(4,30,3)
      COMMON/SRY19/OMEGA,UN,PAS(19),PVS(19),PAR(19),PVR(19)
      COMMON/SRY20/BLOG(19,19),YLOG(19,19)
      COMMON/SRY21/KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X             WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/SRY22/II,EFS,EMR,EMY,EKR(4,30,3),EKY(4,30,3)
      COMPLEX II,EFS(4,30,3),EMR(4,30,3),EMY(4,30,3)
C
C    END OF COMMON DECK
C       (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
      COMPLEX EGS,ENR,ENY,TA
      COMMON /PR23B/ EGS(4,30,3),ENR(4,30,3),ENY(4,30,3)
      DIMENSION TOD(6,6),ROD(6,6),BOD(6,1),INDEX(6,3)
      DO 10 JJ=IFNF,IFNL
      LMT=MIL(JJ)
      IF(LMT.LT.IFRF) GO TO 10
      IFRLL=IFRL
      IF(LMT.LT.IFRL) IFRLL=LMT
      DO 20 N=IFRF,IFRLL
      GXI=OMEN(N)
      GX2=GXI*GXI
      A24V=A24(N)-VCG
      TOD(1,1)=-GX2*(A22(N)+1.)
      TOD(1,2)=-GX2*A24V
      TOD(1,3)=-GX2*A26(JJ,N)
      TOD(1,4)=GXI*B22(JJ,N)
      TOD(1,5)=GXI*B24(JJ,N)
      TOD(1,6)=GXI*B26(JJ,N)
```

```
      TOD(2,1)=-GX2*A24V
      TOD(2,2)=-GX2*(A44(N)+GYRT)+GMT
      TOD(2,3)=-GX2*A46(JJ,N)
      TOD(2,4)=GXI*B24(JJ,N)
C   TOD(2,5) DEFINED IN BETA LOOP
      TOD(2,5)=0.
      TOD(2,6)=GXI*B46(JJ,N)
      TOD(3,1)=-GX2*A62(JJ,N)
      TOD(3,2)=-GX2*A64(JJ,N)
      TOD(3,3)=-GX2*(A66(JJ,N)+GYR)
      TOD(3,4)=GXI*B62(JJ,N)
      TOD(3,5)=GXI*B64(JJ,N)
      TOD(3,6)=GXI*B66(JJ,N)
      TOD(4,1)=-TOD(1,4)
      TOD(4,2)=-TOD(1,5)
      TOD(4,3)=-TOD(1,6)
      TOD(4,4)=TOD(1,1)
      TOD(4,5)=TOD(1,2)
      TOD(4,6)=TOD(1,3)
      TOD(5,1)=-TOD(2,4)
      TOD(5,2)=-TOD(2,5)
      TOD(5,3)=-TOD(2,6)
      TOD(5,4)=TOD(2,1)
      TOD(5,5)=TOD(2,2)
      TOD(5,6)=TOD(2,3)
      TOD(6,1)=-TOD(3,4)
      TOD(6,2)=-TOD(3,5)
      TOD(6,3)=-TOD(3,6)
      TOD(6,4)=TOD(3,1)
      TOD(6,5)=TOD(3,2)
      TOD(6,6)=TOD(3,3)
      DO 45 IT=1,6
      DO 45 IR=1,6
   45 ROD(IT,IR)=TOD(IT,IR)
      DO 30 MM=IBTAF,IBTAL
      DO 46 IT=1,6
      DO 46 IR=1,6
   46 TOD(IT,IR)=ROD(IT,IR)
      SA=GXI*B44(JJ,N,MM)
      TOD(2,5)=SA
      TOD(5,2)=-SA
      TA=EFS(JJ,N,MM)/CON
      BOD(1,1)=REAL(TA)
      BOD(4,1)=AIMAG(TA)
      TA=EMR(JJ,N,MM)/CON
      BOD(2,1)=REAL(TA)
      BOD(5,1)=AIMAG(TA)
      TA=EMY(JJ,N,MM)/CON
      BOD(3,1)=REAL(TA)
      BOD(6,1)=AIMAG(TA)
      CALL MATINS(TOD,6,6,BOD,1,1,DTRM,ID,INDEX)
      IF(ID.EQ.1) GO TO 32
      EFS(JJ,N,MM)=(0.,0.)
      EMR(JJ,N,MM)=(0.,0.)
      EMY(JJ,N,MM)=(0.,0.)
```

```
      IF(IOPT.EQ.2) GO TO 32
      EKR(JJ,N,MM)=0.
      EKY(JJ,N,MM)=0.
      GO TO 30
   32 SA=BOD(1,1)
      SB=BOD(4,1)
      ZRS=SQRT(SA*SA+SB*SB)
      ZIS=-57.295779*ATAN3(SB,SA)
      SA=BOD(2,1)
      SB=BOD(5,1)
      ZRR=RFACT*SQRT(SA*SA+SB*SB)
      ZIR=-57.295779*ATAN3(SB,SA)
      SA=BOD(3,1)
      SB=BOD(6,1)
      ZRY=.5*SQRT(SA*SA+SB*SB)
      ZIY=-57.295779*ATAN3(SB,SA)
      IF(ZIS.GT.90.) ZIS=ZIS-360.
      IF(ZIR.LT.-270.) ZIR=ZIR+360.
      IF(ZIY.LT.-270.) ZIY=ZIY+360.
      EGS(JJ,N,MM)=CMPLX(ZRS,ZIS)
      ENR(JJ,N,MM)=CMPLX(ZRR,ZIR)
      ENY(JJ,N,MM)=CMPLX(ZRY,ZIY)
      IF(IOPT.EQ.2) GO TO 30
      CAY=WN(JJ,N,MM)
      EKR(JJ,N,MM)=ZRR/(CAY*RFACT)
      EKY(JJ,N,MM)=2.*ZRY/CAY
   30 CONTINUE
   20 CONTINUE
   10 CONTINUE
      RETURN
      END




C     ****SUBROUTINES NILS AND QDFCN NOT LISTED--SEE MOT35 LISTING****
C     ****COMMON BLOCKS IN QDFCN SHOULD BE IDENTICAL TO THOSE IN MAIN.****
```

```
      SUBROUTINE FRANK
C
C
      COMMON/SRY1/  NPAG,TITLE(8),PATT(8),RATIO
      COMMON/SRY2/  ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X              NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/SRY3/  NOS,NM(30),BEAM(30),DRFT(30),AREA(30),MPS(30),
     X              DMA(30),AVDA(30),AVBM(30),ST(30),IN(30),SQAR(30),
     X              X(30,20),Y(30,20)
      COMMON/SRY4/  NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X              SNE(19),CSE(19)
      COMMON/SRY5/  VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/SRY6/  NOW,NOL,NSP,NST,WINK(5),SHLT(6),SPEED(6),STAT(20)
      COMMON/SRY7/  NFN,NFNS,FN(6),FNS(6)
      COMMON/SRY8/  NBTA,NBTAS,NBTAT,NBTAQ,WANG(8),COSBET(3),SINBET(3)
      COMMON/SRY9/  NFR,NFRS,OMEN(30),OMENS(30),OMIN,OMAX,DOME,OWAX
      COMMON/SRY10/XZHB,XZPB,XZFO,XZVL,KV,KW
      COMMON/SRY11/CHRDA,THKA,SPNA,FAL,XZFA,CLFA,DEPA,FAY
      COMMON/SRY12/CHRDB,THKB,SPNB,FBL,XZFB,CLFB,DEPB,FBY
      COMMON/SRY13/GRAV,DEPCAT,SD(6),RBMST(10),RBMHT(10)
      COMMON/SRY14/EL,GCB,GYR,GYRT,GM,GMT,GMTS,VCG,RF33,RP35,RM55
      COMMON/SRY15/A26(4,30),A62(4,30),A46(4,30),A64(4,30),A66(4,30)
      COMMON/SRY16/A22(30),A44(30),A24(30),DSR(30),DRR(30)
      COMMON/SRY17/ASY(30),DSY(4,30),AY(30),DY(4,30),ARY(30),DRY(30)
      COMMON/SRY18/B22(4,30),B26(4,30),B62(4,30),B46(4,30),B64(4,30),
     X              B66(4,30),B24(4,30),B44(4,30,3)
      COMMON/SRY19/OMEGA,UN,PAS(19),PVS(19),PAR(19),PVR(19)
      COMMON/SRY20/BLOG(19,19),YLOG(19,19)
      COMMON/SRY21/KASE(4),MIL(4),CWR1(4),CWR2(4),WFR(4,30,3),
     X              WN(4,30,3),SWR(4,30,3),RWS(4,30,3)
      COMMON/SRY22/II,EFS,EMR,EMY,EKR(4,30,3),EKY(4,30,3)
      COMPLEX II,EFS(4,30,3),EMR(4,30,3),EMY(4,30,3)
C
C    END OF COMMON DECK
C       (MAKE ALL CHANGES ABOVE THESE CARDS)
C
      COMMON/ENDCOM/ENDCOM
C
      COMPLEX XU,EKXCD,EKZDY,IDW,ETA235,F26,F4,G26,G64,
     X   SF26(4,30,3),SG26(4,30,3),SF4(4,30,3)
    9 FORMAT(1H0,5X,31HMATRIX IS SINGULAR FOR OMEGA = F7.4)
      CMONO=1.
      IF(MONO.EQ.2) CMONO=2.
      SAREA=AREA(K)*BEAM(K)*DRFT(K)
      IF(BEAM(K) .LE. 1.E-08) SAREA=AREA(K)*DRFT(K)**2
      IF(MPS(K).NE.1) CALL FINIT
      DO 10 N=1,NFR
      OMEGA=OMEN(N)
      UN=OMEGA*OMEGA
      IDW=II/OMEGA
      IF(MPS(K).NE.1) GO TO 12
      DSSA=EKR(1,N,1)
      DSSB=EKR(2,N,1)
      DSRA=EKR(1,N,2)
      DSRB=EKR(2,N,2)
```

```
      DRRA=EKR(1,N,3)
      DRRB=EKR(2,N,3)
      GO TO 17
   12 CALL PRESS
      IF(ID.EQ.1) GO TO 11
      WRITE(6,9) OMEGA
      RETURN
   11 DSSA=0.
      DSSB=0.
      DSRA=0.
      DSRB=0.
      DRRA=0.
      DRRB=0.
      DO 20 I=1,NON
      CON=-DEL(I)*SNE(I)
      IF(MONO.EQ.2) CON=2.*CON
      DSSA=DSSA+CON*PAS(I)
      DSSB=DSSB+CON*PVS(I)
      CON=DEL(I)*(XX(I)*CSE(I)+YY(I)*SNE(I))
      IF(MONO.EQ.2) CON=2.*CON
      DSRA=DSRA+CON*PAS(I)
      DSRB=DSRB+CON*PVS(I)
      DRRA=DRRA+CON*PAR(I)
   20 DRRB=DRRB+CON*PVR(I)
      IF(MPS(K).NE.2) GO TO 17
      EKR(1,N,1)=DSSA
      EKR(2,N,1)=DSSB
      EKR(1,N,2)=DSRA
      EKR(2,N,2)=DSRB
      EKR(1,N,3)=DRRA
      EKR(2,N,3)=DRRB
   17 DSTX=DST*XIP
      DSTXX=DSTX*XIP
      A22(N)=A22(N)+DST*DSSA
      ASY(N)=ASY(N)+DSTX*DSSA
      AY(N)=AY(N)+DSTXX*DSSA
      A24(N)=A24(N)+DST*DSRA
      DSR(N)=DSR(N)+DST*DSRB
      A44(N)=A44(N)+DST*DRRA
      DRR(N)=DRR(N)+DST*DRRB
      ARY(N)=ARY(N)+DSTX*DSRA
      DRY(N)=DRY(N)+DSTX*DSRB
      DO 30 JJ=1,NFN
      XO=XIP+IDW*FN(JJ)
      CONST=0.
      CONSA=0.
      IF(K.GE.KV .AND. K.LE.KW) GO TO 90
      CONST=ON*SAREA*XZHB*FN(JJ)*CMONO
      CONSA = XZPB * CONST
   90 B22(JJ,N)=B22(JJ,N)+DST*(DSSB+CONST)
      DSY(JJ,N)=DSY(JJ,N)+DSTX*(DSSB+CONST)
      DY(JJ,N)=DY(JJ,N)+DSTXX*(DSSB+CONSA)
      IF(MIL(JJ).LT.N) GO TO 30
      DO 33 MM=1,NBTA
      COSB=COSBET(MM)
```

```
      SINB=SINBET(MM)
      WNT=WFR(JJ,N,MM)
      CAY=WN(JJ,N,MM)
      WDW=WNT/OMEGA
      EKXCD=CEXP(II*CAY*XIP*COSB)*DST*CMONO
      IF(MPS(K).NE.1) GO TO 150
      F26=SF26(JJ,N,MM)
      G26=SG26(JJ,N,MM)
      F4=SF4(JJ,N,MM)
      GO TO 160
  150 F26=(0.,0.)
      F4 =(0.,0.)
      G26=(0.,0.)
      G4 =(0.,0.)
      IF(MONO.NE.1) GO TO 32
      DO 41 I=1,NON
      XXI=XX(I)
      YYI=YY(I)
      EKZDY=CEXP(CAY*(YYI-II*XXI*SINB))*DEL(I)
      ETA2=-SNE(I)
      ETA3=CSE(I)
      ETA23S=(-ETA3+II*ETA2*SINB)*EKZDY
      F26=F26 + ETA2*EKZDY
      G26=G26 + ETA23S*(PAS(I)+II*PVS(I))
      F4=F4 + (XXI*ETA3-YYI*ETA2)*EKZDY
      G4=G4 + ETA23S*(PAR(I)+II*PVR(I))
   41 CONTINUE
      G26=WDW*G26
      F4=F4+WDW*G4
      GO TO 18
   32 DO 31 I=1,NON
      YYI=YY(I)
      XXI=XX(I)
      EKZD=EXP(CAY*YYI)*DEL(I)
      ETA2=-SNE(I)
      ETA3=CSE(I)
      CAYYS=CAY*XXI*SINB
      SINKYS=SIN(CAYYS)
      ETA23=(ETA2*SINB*COS(CAYYS)+ETA3*SINKYS)*EKZD
      F26=F26 + ETA2*SINKYS*EKZD
      G26=G26 + ETA23*(PAS(I)+II*PVS(I))
      F4=F4 + (XXI*ETA3-YYI*ETA2)*SINKYS*EKZD
      G4=G4 + ETA23*(PAR(I)+II*PVR(I))
   31 CONTINUE
      F26=-II*F26
      G26=II*WDW*G26
      F4=II*(WDW*G4-F4)
   18 IF(MPS(K).NE.2) GO TO 160
      SF26(JJ,N,MM)=F26
      SG26(JJ,N,MM)=G26
      SF4(JJ,N,MM)=F4
  160 EFS(JJ,N,MM)=EFS(JJ,N,MM) + (F26+G26)*EKXCD
      EMR(JJ,N,MM)=EMR(JJ,N,MM) + F4*EKXCD
      EMY(JJ,N,MM)=EMY(JJ,N,MM) + (XIP*F26+XU*G26)*EKXCD
   33 CONTINUE
   30 CONTINUE
   10 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE FINIT
      COMMON/SRY2/ ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/SRY4/ NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/SRY20/BLOG(19,19),YLOG(19,19)
      DIMENSION X(20),Y(20)
      EQUIVALENCE (XS,X),(YS,Y)
      PI=3.1415927
      DPNL=0.
      DCNL=0.
      PPL=0.
      PCL=0.
      DO 10 I=1,NON
      XM1=XX(I)-X(1)
      YM1=YY(I)-Y(1)
      YP1=YY(I)+Y(1)
      FPR1=.5*ALOG(XM1**2+YM1**2)
      FCR1=.5*ALOG(XM1**2+YP1**2)
      APR1=ATAN2(YM1,XM1)
      ACR1=ATAN2(YP1,XM1)
      IF(I .GE. MAXD) GO TO 30
      IF(YM1 .LT.0.) APR1=APR1+2.*PI
      IF(YP1.GE. 0.) ACR1=-PI
   30 CONTINUE
      IF(MONO .EQ. 1) GO TO 35
      XP1=XX(I)+X(1)
      FPL1=.5*ALOG(XP1**2+YM1**2)
      FCL1=.5*ALOG(XP1**2+YP1**2)
      APL1=ATAN2(YM1,XP1)
      ACL1=ATAN2(YP1,XP1)
   35 CONTINUE
      DO 10 J=1,NON
      XM2=XX(I)-X(J+1)
      YM2=YY(I)-Y(J+1)
      YP2=YY(I)+Y(J+1)
      FPR2=.5*ALOG(XM2**2+YM2**2)
      FCR2=.5*ALOG(XM2**2+YP2**2)
      APR2=ATAN2(YM2,XM2)
      IF(I .GE. MAXD) GO TO 20
      J11=J+1
      IF(I .GE. J11 .AND. APR2 .LE. 0.) APR2=APR2+2.*PI
      IF(J11 .GT. MAXD .AND. APR2 .LT. 0.) APR2=APR2+2.*PI
      IZIP=(APR1-APR2)*10000.0
      ZIP=IZIP
      ZIP=ZIP/10000.0
      IF(ZIP .GT. PI) APR1=APR1-2.*PI
      IF(XM2 .GT. 0.) GO TO 4
      GO TO 5
   20 J1=J+1
      IF(XM2 .GT. 0.) GO TO 4
      IF(J1 .GT. I) GO TO 6
C    **** CARDS BELOW ARE FOR CONVEX OR CONCAVE TOP DECK ***
      IF(YM2 .LT. 0.) APR2=APR2+2.*PI
      GO TO 5
```

```
C **** CARDS BELOW ARE FOR CONVEX,FLAT OR CONCAVE BOTTOM ***
    6 IF(YM2 .GE. 0.) APR2=APR2-2.*PI
    5 IF(YP2 .LT. 0.) GO TO 4
      ACR2=-PI
      GO TO 3
    4 ACR2=ATAN2(YP2,XM2)
    3 SIMJ=SNE(I)*CSE(J)-SNE(J)*CSE(I)
      CIMJ=CSE(I)*CSE(J)+SNE(I)*SNE(J)
      SIPJ=SNE(I)*CSE(J)+SNE(J)*CSE(I)
      CIPJ=CSE(I)*CSE(J)-SNE(I)*SNE(J)
      DPNR=SIMJ*(FPR1-FPR2)+CIMJ*(APR1-APR2)
      PPR=CSE(J)*(XM1*FPR1-YM1*APR1-XM1-XM2*FPR2+YM2*APR2+XM2)+SNE(J)*(Y
     1M1*FPR1+XM1*APR1-YM1-YM2*FPR2-XM2*APR2+YM2)
      DCNR=SIPJ*(FCR1-FCR2)+CIPJ*(ACR1-ACR2)
      PCR=CSE(J)*(XM1*FCR1-YP1*ACR1-XM1-XM2*FCR2+YP2*ACR2+XM2)+SNE(J)*(Y
     1P2*FCR2+XM2*ACR2+YP1-YP1*FCR1-XM1*ACR1-YP2)
      IF(MONO .EQ. 1) GO TO 37
      XP2=XX(I)+X(J+1)
      FPL2=.5*ALOG(XP2**2+YM2**2)
      FCL2=.5*ALOG(XP2**2+YP2**2)
      APL2=ATAN2(YM2,XP2)
      ACL2=ATAN2(YP2,XP2)
      DPNL=SIPJ*(FPL2-FPL1)+CIPJ*(APL2-APL1)
      PPL=CSE(J)*(XP2*FPL2-YM2*APL2-XP2-XP1*FPL1+YM1*APL1+XP1)+SNE(J)*(Y
     1M1*FPL1+XP1*APL1+YM2-YM2*FPL2-XP2*APL2-YM1)
      DCNL=SIMJ*(FCL2-FCL1)+CIMJ*(ACL2-ACL1)
      PCL=CSE(J)*(XP2*FCL2-YP2*ACL2-XP2-XP1*FCL1+YP1*ACL1+XP1)+SNE(J)*(Y
     1P2*FCL2+XP2*ACL2-YP2-YP1*FCL1-XP1*ACL1+YP1)
   37 CONTINUE
      BLOG(I,J)=DPNR-DPNL-DCNR+DCNL
      YLOG(I,J)=PPR-PPL-PCR+PCL
      IF(J.EQ.NON) GO TO 10
      XM1=XM2
      YM1=YM2
      FPR1=FPR2
      FCR1=FCR2
C   **** NEXT CARD HANDLES ANGLE DIFFERENCE ACROSS MAXD POINT ****
      IF(I .LT. MAXD .AND. (J+1).EQ. MAXD .AND. APR2 .LT. 0.) APR2=APR2
     1+ 2.*PI
      APR1=APR2
      ACR1=ACR2
      YP1=YP2
      IF(MONO .EQ. 1) GO TO 10
      XP1=XP2
      FPL1=FPL2
      FCL1=FCL2
      APL1=APL2
      ACL1=ACL2
   10 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE PRESS
      COMMON/SRY2/ ID,IG,IP,IND,ISD,ISTART,JA,JB,JC,K,LP,MAXD,MONO,MS,
     X             NIX,NLOOP,NSD,NSO,NSTR,NUX
      COMMON/SRY4/ NUT,NON,NOE,XS(20),YS(20),XX(19),YY(19),DEL(19),
     X             SNE(19),CSE(19)
      COMMON/SRY5/ VOL,XIP,DST,PST,BAM,DRT,AIR,AMP1,AMP2,DS(30),SS(30)
      COMMON/SRY19/OMEGA,UN,PAS(19),PVS(19),PAR(19),PVR(19)
      COMMON/SRY20/BLOG(19,19),YLOG(19,19)
      DIMENSION CON(38,2),CT(38,38),SOUR(19,19),WAVE(19,19)
      DIMENSION INDEX(38,3)
      DIMENSION X(20),Y(20)
      EQUIVALENCE (XS,X),(YS,Y)
      DPL=0.
      PPL=0.
      DWL=0.
      PWL=0.
      DO 10 I=1,NON
      NI=NON+I
      CON(I,1)=0.0
      CON(I,2)=0.0
      SN=SNE(I)
      CON(NI,1)=-OMEGA*SN
      CON(NI,2)=OMEGA*(XX(I)*CSE(I)+YY(I)*SN)
   22 XR1=UN*(XX(I)-X(1))
      YR1=-UN*(YY(I)+Y(1))
      CALL DAVID(XR1,YR1,EJ1,CXR1,SXR1,RAR1,RBR1,CR1,SR1)
      IF(MONO .EQ. 1) GO TO 37
      XL1=UN*(XX(I)+X(1))
      YL1=YR1
      CALL DAVID(XL1,YL1,EJ1,CXL1,SXL1,RAL1,RBL1,CL1,SL1)
   37 CONTINUE
      DO 10 J=1,NON
      NJ=NON+J
      SIPJ=SNE(I)*CSE(J)+SNE(J)*CSE(I)
      CIPJ=CSE(I)*CSE(J)-SNE(I)*SNE(J)
      XR2=UN*(XX(I)-X(J+1))
      YR2=-UN*(YY(I)+Y(J+1))
      CALL DAVID(XR2,YR2,EJ2,CXR2,SXR2,RAR2,RBR2,CR2,SR2)
      DPR=2.*(SIPJ*(CR1-CR2)-CIPJ*(SR1-SR2))
      PPR=2./UN*(SNE(J)*(RAR1-RAR2)+CSE(J)*(RBR1-RBR2))
      DWR=6.2831853*(EJ2*(SXR2*CIPJ-CXR2*SIPJ)-EJ1*(SXR1*CIPJ-CXR1*SIPJ)
     1)
      PWR=6.2831853/UN*(EJ1*(SXR1*CSE(J)-CXR1*SNE(J))-EJ2*(SXR2*CSE(J)-
     1CXR2*SNE(J)))
      IF(MONO .EQ. 1) GO TO 38
      SIMJ=SNE(I)*CSE(J)-SNE(J)*CSE(I)
      CIMJ=CSE(I)*CSE(J)+SNE(I)*SNE(J)
      XL2=UN*(XX(I)+X(J+1))
      YL2=YR2
      CALL DAVID(XL2,YL2,EJ2,CXL2,SXL2,RAL2,RBL2,CL2,SL2)
      DPL=2.*(CIMJ*(SL1-SL2)-SIMJ*(CL1-CL2))
      PPL=2./UN*(SNE(J)*(RAL1-RAL2)+CSE(J)*(RBL2-RBL1))
      DWL=6.2831853*(EJ1*(SXL1*CIMJ-CXL1*SIMJ)-EJ2*(SXL2*CIMJ-CXL2*SIMJ)
     1)
      PWL=6.2831853/UN*(EJ2*(SXL2*CSE(J)+CXL2*SNE(J))-EJ1*(SXL1*CSE(J)+
     1CXL1*SNE(J)))
```

```
38 CONTINUE
   CT(I,J)=BLOG(I,J)+DPR-DPL
   CT(NI,NJ)=CT(I,J)
   CT(I,NJ)=DWR-DWL
   CT(NI,J)=-CT(I,NJ)
   SOUR(I,J)=YLOG(I,J)+PPR-PPL
   WAVE(I,J)=PWR-PWL
   IF(J.EQ.NON) GO TO 10
   XR1=XR2
   YR1=YR2
   EJ1=EJ2
   CR1=CR2
   SR1=SR2
   RAR1=RAR2
   RBR1=RBR2
   CXR1=CXR2
   SXR1=SXR2
   IF(MONO .EQ. 1) GO TO 10
   XL1=XL2
   YL1=YL2
   CL1=CL2
   SL1=SL2
   RAL1=RAL2
   RBL1=RBL2
   CXL1=CXL2
   SXL1=SXL2
10 CONTINUE
   CALL MATINS(CT,38,NOE,CON,2,2,DTRM,ID,INDEX)
   IF(ID.EQ.2) RETURN
   DO 20 I=1,NON
   PAS(I)=0.
   PVS(I)=0.
   PAR(I)=0.
   PVR(I)=0.
   DO 30 J=1,NON
   NJ=NON+J
   CJ=CON(J,1)
   CNJ=CON(NJ,1)
   WV=WAVE(I,J)
   SR=SOUR(I,J)
   PAS(I)=PAS(I)+CJ*WV-CNJ*SR
   PVS(I)=PVS(I)+CJ*SR+CNJ*WV
   CJ=CON(J,2)
   CNJ=CON(NJ,2)
   PAR(I)=PAR(I)+CJ*WV-CNJ*SR
30 PVR(I)=PVR(I)+CJ*SR+CNJ*WV
   PAS(I)=OMEGA*PAS(I)
   PVS(I)=OMEGA*PVS(I)
   PAR(I)=OMEGA*PAR(I)
20 PVR(I)=OMEGA*PVR(I)
77 RETURN
   END
```

```
C   ****SUBROUTINE DAVID, FUNCTION ATAN3, SUBROUTINE MATINS, AND PROGRAM
C   ****PGM4 NOT LISTED--SEE MOT35 LISTING****
C   ****COMMON BLOCKS IN PGM4 SHOULD BE THE SAME AS THOSE IN MAIN.****
C   ****THE LAST 2 LINES IN PGM4 SHOULD BE CHANGED TO THE FOLLOWING****
       CALL AETSKC(6LMOT246)
       END
C   ****


       OVERLAY(5,0)
       PROGRAM PGM5
C
C   FOR FUTURE CALCULATION OF RESPONSES TO IRREGULAR SEAS
       CALL AETSKC(6LMOT246)
       END


C   ****SUBROUTINE SEAST NOT LISTED--SEE MOT35 LISTING****


C   ****PROGRAM PGM1A NOT LISTED--SEE MOT35 LISTING****
C   ****COMMON BLOCKS SHOULD BE THE SAME AS THOSE IN MAIN.****
C   ****THE LAST 4 LINES IN PGM1A SHOULD BE CHANGED TO THE FOLLOWING****
       IF(ID.EQ.2 .OR. ID.EQ.-1) CALL AETSKC(6LMOT246)
       IF(LP.EQ.2 .OR. ID.EQ.-1) .AND. NOW.EQ.0) CALL AETSKC(6LMOT246)
       IF(LP.LE.0 .AND. IP.LE.0) CALL AETSKC(4LPGM5)
       END
C****
```

APPENDIX C

Determination of Encounter Frequencies

in Following Waves

For cases where β, the wave heading angle, is at least 90 degrees, motion calculations are made as a function of the encounter frequencies specified by the input variable OMEN(I). These values and the Froude number, F_n, are used to calculate corresponding wave frequencies and wavelengths. However, for β values where $0<\beta<90$ the frequencies are caluclated using the input variables indicating the desired wave length range and the Froude numbers. The program PGM1A is used to determine the encounter frequency values.

The determination of encountering frequency is divided into three regions:

1. Waves which propagate faster than the ship speed, $V_s << V_w$
2. Waves which propagate at about the same speed as the ship speed. $V_s < V_w$
3. Waves which propagate slower than ship speed, $V_s > V_w$

where V_s is the ship speed and V_w is the wave speed.

The above three regions are considered in sequence. In the input, the RWS(1,I,1) values indicate the desired (wave length)/(ship length) values and the RWS(1,I,2) values indicate steps to be used between successive wave length values. These values and the requested Froude number values are used to determine what combinations of Froude number and encounter frequency fall within each region.

The relationships between the non-dimensional wave frequency, ω_o, and the non-dimensional encounter frequency, $\bar{\omega}$, and Froude number, F_n, for each region are described below.

1. Wave Frequencies in Regions 1 and 2.

For the wave frequency, ω_o, the celerity of the wave, C, in deep water is given by

$$C = \frac{g}{\omega_o}$$

where g is the gravitational acceleration

When the ship velocity U is less than C sec β, we find the wave-encountering frequency by

$$\omega = \omega_o\left(1 - \frac{U}{C \sec \beta}\right) = \omega_o\left(1 - \frac{U\omega_o \cos \beta}{g}\right) \quad \text{for } 0 \leq \beta < \frac{\pi}{2} \qquad (1)$$

If we let

$$\bar{\omega} = \omega\sqrt{\frac{L}{g}},\ \bar{\omega}_o = \omega_o\sqrt{\frac{L}{g}},\ \bar{\lambda} = \frac{\lambda}{L},\ \text{and } F_n = \frac{U}{\sqrt{gL}}$$

where L is the ship length (given by EL in the program) and λ is the wave length, we get

$$\bar{\lambda} = \frac{2\pi}{\bar{\omega}_o^{\,2}}$$

$$\bar{\omega} = \sqrt{\frac{2\pi}{\bar{\lambda}}}\left(1 - F_n\sqrt{\frac{2\pi}{\bar{\lambda}}}\cos\beta\right) \quad \text{for } F_n < \frac{1}{\sqrt{\frac{2\pi}{\bar{\lambda}}}\cos\beta} \qquad (2)$$

We can also write $\bar{\omega}_o$ as

$$\bar{\omega}_o = \frac{1 \pm \sqrt{1 - 4\bar{\omega}F_n\cos\beta}}{2F_n\cos\beta} \qquad (3)$$

We note that for $\bar{\omega} < \frac{1}{4F_n\cos\beta}$, we have two different wave frequencies or wave lengths for a given encounter frequency, ship speed and wave heading. That means that there exist two different values of $\bar{\lambda}$, say $\bar{\lambda}_1$ and $\bar{\lambda}_2$, to provide an identical $\bar{\omega}$ by Equation (2) for fixed values of F_n and β.

From Equation (1), we can derive

$$\bar{\omega} \quad \bar{\omega}_o - F_n\,\bar{\omega}_o^{\,2}\cos\beta$$

or

$$F_n = \frac{1}{\bar{\omega}_o\cos\beta}\left(1 - \frac{\bar{\omega}}{\bar{\omega}_o}\right) \qquad (4)$$

Case 1 (Region 1):

$$\bar{\omega}_o = \frac{1 + \sqrt{1 - 4\bar{\omega}F_n\cos\beta}}{2F_n\cos\beta} \qquad (5)$$

For given arrays of ω_o (or λ) and β, the minimum Froude number can be obtained by

$$(F_n)_m = \frac{1}{2(\bar{\omega}_o)_M\cos\beta} = \frac{1}{2\sqrt{\frac{2\pi}{\bar{\lambda}_m}}\cos\beta} \qquad (6)$$

from Equation (5) where the subscripts m and M respectively mean minimum and maximum values. For given arrays of ω_o and β and a minimum values of $\bar{\omega}$ (defines as OMIN in the program), the maximum Froude number is obtained by

$$(F_n)_M = \frac{1}{(\bar{\omega}_o)_m \cos\beta}\left(1 - \frac{\bar{\omega}_m}{(\bar{\omega}_o)_m}\right) \tag{7}$$

$$= \frac{1}{\sqrt{2\pi/\lambda_M}\ \beta}\left(1 - \frac{\bar{\omega}_m}{\sqrt{2\pi/\lambda_M}}\cos\beta\right)$$

from Equation (4)

Case 2 (Region 2):

$$\omega_o = \frac{1 - \sqrt{1 - 4\,\bar{\omega} F_n \cos\beta}}{2\,F_n \cos\beta}$$

$$(F_n)_m \to o \tag{8}$$

$$(F_n)_M = \frac{1}{2(\bar{\omega}_o)_m \cos\beta} = \frac{1}{2\sqrt{\frac{2\pi}{\bar{\lambda}_m}}\cos\beta} \tag{9}$$

2. Wave frequencies in Region 3

Case 3 (Region 3):

$$\bar{\omega} = \sqrt{\frac{2\pi}{\lambda}}\left(F_n\sqrt{\frac{2\pi}{\lambda}}\cos\beta - 1\right) \text{ for } F_n < \frac{1}{\sqrt{\frac{2\pi}{\lambda}}\cos\beta} \tag{10}$$

$$F_n = \frac{1}{\bar{\omega}_o \cos\beta}\left(\frac{\bar{\omega}}{\bar{\omega}_o} - 1\right) \tag{11}$$

$$\bar{\omega}_o = \frac{1 + \sqrt{1 + 4\bar{\omega}\,F_n \cos\beta}}{2\,F_n \cos\beta} \tag{12}$$

$$(F_n)_m = \frac{1}{2(\bar{\omega}_o)_m \cos\beta} = \frac{1}{2\sqrt{2\pi/\lambda_m}\cos\beta} \tag{13}$$

$$(F_n)_M = \frac{1}{\sqrt{2\pi/\lambda_M}\cos\beta}\left(\frac{\bar{\omega}_M}{\sqrt{2\pi/\lambda_M}} - 1\right) \tag{14}$$

For given arrays of $\bar{\omega}$ and β, proper bounds of F_n are found in Cases 1 through 3, and if any of the F_n values given as input data are found within the bounds in each case, the encounter frequencies are calculated by Equation (2) for Cases 1 and 2 and by Equation (10) for Case 3. The foregoing procedure is performed in PGM1A.

APPENDIX D

DATA INPUT DESCRIPTIONS

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DATA SET*	FORMAT	COLUMNS	FORTRAN NAME	DESCRIPTION
1	8A6	1-48	TITLE(I)	Descriptive title to be used at the top of each output page
2A	2I5	5	MONO	Define as: 0 for twin-hull configuration 1 for mono-hull configuration with asymmetric cross sections 2 for mono-hull configuration with symmetric cross sections
		10	JA	Define as: 1 if all wave heading angles β (WANG (I)) are such that $90° \leq$ WANG(I) $\leq 180°$ 2 if any β is less than 90° 3 if only preliminary geometric computations are desired. Recommended for first run.
2B	2F10.5	1-10	SCALE	Scale factor for all linear input (except the data input for the fins). Default value of 1.
		11-20	GRAV	Default value of 32.174. Use 9.807 if length units are given in meters rather than feet.
3	12I5	4-5	NFR	Number of frequencies (OMEN(I)) to be given. Maximum value of 30
		10	NBTA	Number of heading angles (WANG(I)) to be given. Maximum value of 3.
		15	NFN	Number of Froude numbers (FN(I)) to be given. Maximum value of 4.
		20	NSD	Number of hull separations. (SD(I)) for twin-hull configuration only. Define as 1.
		24-25	NSTR	Number of locations (RBMST(I)) for calculation of absolute motion, velocity and acceleration. Relative motion is also calculated in MOT35. Maximum value of 10.
		29-30	NOS	Number of stations for which offset information is given. Maximum value of 30.
		35	NLOOP	Maximum number of iterations for solution of damping and motion equations in PR2B. Value of 3 should be adequate.

* A unique data identifier indicates that a new card should be used. If an array is being defined, a data set may consist of more than one card of the same format.

DATA SET	FORMAT	COLUMNS	FORTRAN NAME	DESCRIPTION
		40	IG	Control variable which determines the extent of the printed output. Values for motions and phases are always given. Define as: 0 for no additional output 1 for exciting forces and moments 2 for exciting forces and moments and added mass and damping coefficients 3 for exciting forces and moments added mass and damping coefficients, and intermediate values of motions if NLOOP > 0.
		45	LP	Controls charactron plotting Define as: 0 for no plots 1 for plots of offsets (Define JA as 3.)
		50	IND	Define as: 0 for typical computer runs 1 for storing motion data on file. For use witha modified version of SMOTION which provides motion results in irregular seas.
4	8F10.5		OMEN(I)	Non-dimensional encounter frequencies for which calculations are desired. OMEN(I) = $\omega / \sqrt{g/EL}$ where EL is defined in data set 10. This input is used for calculations for all speeds $90^{o} \leq \beta < 180^{o}$. ($I \leq NFR \leq 30$)
5	4F10.5		WANG(I)	Angle of incidence of wave train relative to the direction of ship, given in degrees. Defined as 180^{o} for head seas, 0^{o} for following seas. Must be given in the order of increasing values between 0 and 180. ($I \leq NBTA \leq 3$)
6	8F10.5		FN(I)	Froude number = (forward velocity)/$\sqrt{g(EL)}$. ($I \leq NFN \leq 4$)
7	8F10.5		SD(I)	For twin-hull ship define as half the distance between the centerlines of hulls. ($I \leq NSD \leq 6$) For mono-hull use blank card.
8A	8F10.5		RBMST(I)	Desired longitudinal locations at which absolute displacement, velocity, and acceleration as well as relative displacement (MOT35 only) are to be calculated. The values should be given as distances from ST(I) = 0. to the point of interest in the same unit as EL times (20./EL) (See Data Set 13) ($I \leq NSTR \leq 10$)

DATA SET	FORMAT	COLUMNS	FORTRAN NAME	DESCRIPTION
8B	8F10.5		RBMHT(I)	Desired vertical locations of the hull at the longitudinal locations given by RBMST(I) from the calm waterline at which absolute lateral displacement, velocity and acceleration are to be calculated. This input is needed only for MOT246. Give blank card(s) for MOT35. The values should be given in the same dimensional unit as EL. A positive or negative sign should be assigned depending on whether the point is above or below the calm waterline ($I \leq NSTR \leq 10$).

THE FOLLOWING DATA SET IS TO BE INCLUDED ONLY IF AT LEAST ONE VALUE OF WANG (I) IS LESS THAN 90. (THAT IS, IF JA = 2)

DATA SET	FORMAT	COLUMNS	FORTRAN NAME	DESCRIPTION
9A	8F10.5		RWS(1,I,1)	Bounds of λ/L (wave length divided by EL) for which calculations are desired. Maximum of 8 values.
9B	7F10.5		RWS(2,I,1)	Increments of λ/L to be used between successive pairs of RWS(1,I,1) to RWS(1, I+1, 1) in increments of RWS(2,I,1), for up to 7 sets.
9C	3F10.5	1-10	OMIN	Minimum value of encounter frequency divided by $\sqrt{g/EL}$ for which calculations are desired.
		11-20	OMAX	Maximum values of non-dimensional encounter frequency.
		21-30	DOME	Increment to be used for non-dimensional encounter frequency.
10	8F10.5	1-10	EL	Distance between Station 0 and Station 20. This value is used for non-dimensionalization in the program and should be used in defining GYR, GYRT, OMEN(I), FN(I), RWS(1,I,1), RWS(2,I,1)
		11-20	GYR	The pitch or yaw radius of gyration divided by EL.
		21-30	GYRT	The roll radius of gyration divided by EL. Needed for MOT246 only.

DATA SET	FORMAT	COLUMNS	FORTRAN NAME	DESCRIPTION
		31-40	GCB	Longitudinal center of buoyancy given in station number, normally between 0. and 20. Does not have to be an integer. Will be calculated in program if defined as 0.
		41-50	VCG	Vertical center of gravity referenced to waterline (Positive if above waterline, negative otherwise).
		51-60	GMT	Transverse metacentric height. Used in MOT246 only. Will be calculated in MOT246 if define as 0.
		61-70	DEPCAT	If MONO = 0 (twin-hull), define as vertical distance (positive number) between waterline and maximum breadth point of hull. Otherwise define as 0.
		71-80	BRCL	Used only in irregular sea calculations (NOW>0) If MONO = 0, define as distance (positive number) between waterline and the bottom of cross deck. Otherwise defined as 0.
		DATA FOR FIN A AND FIN B		
11A	8F10.5	1-10	FAL	Longitudinal distance between Station 0 to quarter chord of fin
		11-20	FAY	Transverse distance between longitudinal plane of symmetey of two hulls (or one hull for momo-hull) and the centroid of fin
		21-30	DEPA	Vertical distance between waterline and mean depth of fin
		31-40	CHRDA	Chord of fin
		41-50	SPNA	Geometric span of fin. If the fin is full-span (spans the entire distance between hulls), then define as half that distance.
		51-60	THKA	Maximum thickness of fin.
		61-70	CLFA	Lift-curve slope (per radian) for fin.
		71-80	XZFA	Drag coefficient. Approximated by 1.2, the value for a flat plate attached to a wall in a uniform flow normal to the plate.

DATA SET	FORMAT	COLUMN	FORTRAN NAME	DESCRIPTION
	8F10.5		FBL	Data for second fin.
			FBY	
			DEPB	
			CHRDB	
			SPNB	
			THKB	
			CLFB	
			XZFB	
12			XZFO	Body cross-flow drag coefficients denoted as C_D in Reference 1. For SWATH with circular cross sections for main hull, 0.5 has been used.
			XZVL	Body viscous-lift coefficient denoted as a_o in Reference 1. For SWATH with circular cross sections for main hull, 0.07 has been used.
			XZHB	Heave viscous damping coefficient for effect of bulbous bow shape. Used only in MOT35. Define as zero except for mono-hull or conventional catamaran which has a bulbous bow.
			XZPB	Pitch viscous damping coefficient for effect of bulbous bow shape. Used only in MOT35. Define as zero except for mono-hull or catamaran which has a bulbous bow.
		45	KV	Sequenced integer number (counting from the foremost station as 1) of first station without bulbous shape.
		50	KW	Sequenced integer number (counting from the foremost station as 1) of last station without bulbous shape.

ONE CARD OF THE FOLLOWING FORMAT MUST BE PROVIDED FOR EACH STATION. A TOTAL OF NOS CARDS MUST BE GIVEN. AT PRESENT ONLY ST(I), NM(I) AND MPS(I) NEED BE DEFINED. (THE OTHER VARIABLES ARE USED IN OTHER PROGRAMS FOR MONO-HULL SHIPS FOR THE LEWIS-FORM FIT WHICH IS NOT INCLUDED IN THE PRESENT PROGRAMS)

DATA SET	FORMAT	COLUMNS	FORTRAN NAME	DESCRIPTION
13	4F9.4, 2 I9	1-9	ST(I)	Station number of the Ith section given in a scale of 20.0 from the forward reference station designated as Station 0. The value can be negative if the station is ahead of Station 0 or it can be greater than 20, if the station is aft of Station 20. The stations corresponding to ST (1), ST(I) = 0, ST (I) = 10., ST(I) = 20., ST(NOS) should always be given. The stations between the foregoing stations should be chosen such that pairs of even spacing between the stations starting from ST(I) = 0, and ST(I) = 20.0 in either direction can be maintained. $(I \leq NOS \leq 30)$
		10-18	Beam (I)	Define as 0.
		19-27	DRFT (I)	Define as 0.
		28-36	AREA (I)	Define as 0.
		44-45	NM (I)	Number of offset points used to describe the Ith station. Maximum of 20. For mono-hull ships, 10 is usually adequate.
		54	MPS (I)	Used to indicate location of parallel middle body Define as: 0 is station is not part of the parallel middle body 1 for first station of parallel middle body 2 for all but the first station which is part of the parallel middle body

DATA SET 14 IS REPEATED NOS TIMES, ONCE FOR EACH STATION

DATA SET	FORMAT	COLUMNS	FORTRAN NAME	DESCRIPTION
14	8F9.4		X(I,J)	The value of the x-coordinates of the points on the immersed cross sectional contour given in the same dimensional unit as EL with respect to the coordinate system shown in Figure 2. $(I \leq NOS \leq 30,\ J \leq NM\ (I) \leq 20)$ All values (NM(I) in number) for the Ith station are to be given with 8 per card.

DATA SET	FORMAT	COLUMN	FORTRAN NAME	DESCRIPTION
	8F9.4		Y(I,J)	The values of the y-coordinate of the point corresponding to X(I,J) as shown in Figure 2. ($I \leq NOS \leq 30$), $J \leq NM(I) \leq 20$) All values (NM(I) in number) for the Ith station are to be given with 8 per card.
15	4I5	5	NOW	Number of significant wave heights (WINK (I)) to be chosen.
		10	NOL	Number of ship lengths (SHLT(I)) to be chosen
		15	NSP	Number of ship speeds (SPEED(I)) to be chosen
		19-20	NST	Number of stations (STAT(I)) to be chosen

CARD SETS 16A-16D ARE TO BE USED ONLY IF NOW IS GREATER THAN 0. THEN THE FOLLOWING DATA ARE USED TO COMPUTE MOTIONS IN IRREGULAR SEAS USING THE PIERSON-MOSKOWITZ SPECTRUM FORMULA.

16A	8F10.5		WINK(I)	Significant wave heights in feet ($I \leq NOW \leq 5$)
16B	8F10.5		SHLT(I)	Ship length (as defined by EL but not necessarily the same value) ($I \leq NOL \leq 6$). When this value is other than that given by EL, all the ships dimensions are proportionally scaled.
16C	8F10.5		SPEED(I)	Ship speed in knots. ($I \leq NSP \leq 6$)
16D	8F10.5		STAT(I)	Station number given in a scale of 20 similar to ST(I) (See Data Set 13) where significant amplitude of absolute and relative (MOT35 only) displacement, velocity and acceleration are to be calculated ($I \leq NST \leq 20$)

USE THE FOLLOWING DATA SET ONLY WHEN PLOTTING OFFSETS (LP=1)

17	3A10		NAME1	User's name.
			NAME2	User's code.
			NAME3	User's telephone extension.

IN ORDER TO MAKE CALCULATIONS FOR ADDITIONAL SHIP CONFIGURATIONS, REPEAT DATA SETS 1-16 FOR EACH CONFIGURATION.

18A				Blank Card.
18B				Blank Card.

APPENDIX E

SAMPLE COMPUTER INPUT AND OUTPUT

SAMPLE RUN 1 - MOT246 OUTPUT (IG = 2) FOR COMPUTER RUN FOR TWO HEADINGS AND TWO FROUDE NUMBERS

```
MOT246    SWAY, ROLL AND YAW MOTIONS OF     SWATH 6A                                                  PAGE   1

DATA INPUT CARDS
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
 SWATH 6A
   0   1
   0.00000   0.00000
  16    2    2    1    1   19    3    2    0    0
    .90000   1.00000   1.20000   1.30000   1.40000   1.50000   1.60000   1.70000
   1.80000   1.90000   2.00000   2.20000   2.40000   2.70000   3.00000   3.50000
  90.00000 135.00000
   0.00000    .44600
  37.50000
   1.00000
   0.00000
 178.14000    .31500    .22300   0.00000   7.44000  11.06000  19.17000  20.00000
  40.44000  25.75000  19.17000   8.50000  10.20000   1.28000   4.38000   1.20000
 188.12000  23.55000  19.17000  14.70000  17.60000   2.20000   3.43000   1.20000
    .50000    .07000   0.00000   0.00000    0   19
   -1.6000    0.0000    0.0000    0.0000        9         0
    -.8000    0.0000    0.0000    0.0000        9         0
    0.0000    0.0000    0.0000    0.0000        9         0
    1.0000    0.0000    0.0000    0.0000        9         0
    2.0000    0.0000    0.0000    0.0000       15         0
    3.0000    0.0000    0.0000    0.0000       15         0
    4.0000    0.0000    0.0000    0.0000       15         0
    6.0000    0.0000    0.0000    0.0000       15         0
    8.0000    0.0000    0.0000    0.0000       15         2
   10.0000    0.0000    0.0000    0.0000       15         1
   12.0000    0.0000    0.0000    0.0000       15         1
   14.0000    0.0000    0.0000    0.0000       15         1
   16.0000    0.0000    0.0000    0.0000       15         1
   18.0000    0.0000    0.0000    0.0000       15         0
   20.0000    0.0000    0.0000    0.0000       15         0
   22.0000    0.0000    0.0000    0.0000        9         0
   24.0000    0.0000    0.0000    0.0000        9         0
   24.5000    0.0000    0.0000    0.0000        9         0
   25.0000    0.0000    0.0000    0.0000        9         0
```

			STATION	-1.6000			
0.0000	-2.0200	-2.7900	-1.9600	0.0000	1.9800	2.8100	2.0000
0.0000							
10.3100	9.4500	7.5100	5.5000	4.7100	5.5300	7.5300	9.5000
10.3100							
			STATION	-.8000			
0.0000	-3.7420	-5.2920	-3.7420	0.0000	3.7420	5.2920	3.7420
0.0000							
12.7920	11.2420	7.5000	3.7580	2.2080	3.7580	7.5000	11.2420
12.7920							
			STATION	0.0000			
0.0000	-4.3800	-6.1100	-4.3000	0.0000	4.3600	6.1400	4.3300
0.0000							
13.6300	11.7800	7.5000	3.1500	1.4000	3.1900	7.5500	11.8400
13.6300							
			STATION	1.0000			
0.0000	-4.8500	-6.7800	-4.7500	0.0000	4.8200	6.8200	4.8200
0.0000							
14.3200	12.2600	7.5300	2.6800	.7300	2.7100	7.5400	12.3000
14.3200							
			STATION	2.0000			
-1.0600	-1.0600	-1.0600	-1.0600	-5.1600	-7.2400	-5.0700	0.0000
5.1100	7.2300	5.1200	1.0600	1.0600	1.0600	1.0600	
26.6800	22.7200	18.7800	14.6800	12.5900	7.5200	2.3900	.3400
2.4300	7.5600	12.6500	14.6800	18.7800	22.7200	26.6800	
			STATION	3.0000			
-2.1700	-2.1700	-2.1700	-2.1700	-5.3200	-7.4400	-5.2000	0.0000
5.2400	7.4200	5.2400	2.1700	2.1700	2.1700	2.1700	
26.6600	22.6400	18.6400	14.6200	12.7200	7.5200	2.2500	.1100
2.2900	7.5600	12.7900	14.6200	18.6400	22.6400	26.6600	
			STATION	4.0000			
-3.0000	-3.0000	-3.0000	-3.0000	-5.3600	-7.5300	-5.2800	0.0000
5.3100	7.5000	5.3000	3.0000	3.0000	3.0000	3.0000	
26.6600	22.5700	18.4600	14.3700	12.7700	7.5000	2.1800	0.0000
2.2300	7.5600	12.8400	14.3700	18.4600	22.5700	26.6600	
			STATION	6.0000			
-3.5600	-3.5600	-3.5600	-3.5600	-5.3700	-7.5300	-5.2700	0.0000
5.3400	7.5600	5.3700	3.5600	3.5600	3.5600	3.5600	
26.6400	22.4800	18.3200	14.1600	12.7900	7.5200	2.1700	0.0000
2.1800	7.5500	12.8500	14.1600	18.3200	22.4800	26.6400	
			STATION	8.0000			
-3.6200	-3.6200	-3.6200	-3.6200	-5.3700	-7.5300	-5.2700	0.0000
5.3400	7.5600	5.3700	3.6200	3.6200	3.6200	3.6200	
26.6400	22.4600	18.2800	14.1100	12.7900	7.5200	2.1700	0.0000
2.1800	7.5500	12.8500	14.1100	18.2800	22.4600	26.6400	
			STATION	10.0000			
-3.6200	-3.6200	-3.6200	-3.6200	-5.3700	-7.5300	-5.2700	0.0000
5.3400	7.5600	5.3700	3.6200	3.6200	3.6200	3.6200	
26.6400	22.4600	18.2800	14.1100	12.7900	7.5200	2.1700	0.0000
2.1800	7.5500	12.8500	14.1100	18.2800	22.4600	26.6400	

			STATION	12.0000			
-3.6200	-3.6200	-3.6200	-3.6200	-5.3700	-7.5300	-5.2700	0.0000
5.3400	7.5600	5.3700	3.6200	3.6200	3.6200	3.6200	
26.6400	22.4600	18.2800	14.1100	12.7900	7.5200	2.1700	0.0000
2.1800	7.5500	12.8500	14.1100	18.2800	22.4600	26.6400	
			STATION	14.0000			
-3.6200	-3.6200	-3.6200	-3.6200	-5.3700	-7.5300	-5.2700	0.0000
5.3400	7.5600	5.3700	3.6200	3.6200	3.6200	3.6200	
26.6400	22.4600	18.2800	14.1100	12.7900	7.5200	2.1700	0.0000
2.1800	7.5500	12.8500	14.1100	18.2800	22.4600	26.6400	
			STATION	16.0000			
-3.6100	-3.6100	-3.6100	-3.6100	-5.3700	-7.5300	-5.2700	0.0000
5.3400	7.5600	5.3700	3.6100	3.6100	3.6100	3.6100	
26.7000	22.5200	18.3400	14.1500	12.7900	7.5200	2.1700	0.0000
2.1800	7.5500	12.8500	14.1500	18.3400	22.5200	26.7000	
			STATION	18.0000			
-3.1100	-3.1100	-3.1100	-3.1100	-5.3000	-7.4800	-5.2500	0.0000
5.3300	7.4900	5.2700	3.1100	3.1100	3.1100	3.1100	
26.6800	22.5700	18.4500	14.3400	12.8200	7.5400	2.2400	0.0000
2.2700	7.5700	12.8200	14.3400	18.4500	22.5700	26.6800	
			STATION	20.0000			
-1.4300	-1.4300	-1.4300	-1.4300	-5.0100	-7.1000	-4.9800	0.0000
5.0600	7.1100	5.0100	1.4300	1.4300	1.4300	1.4300	
26.6900	22.6100	18.5300	14.4600	12.5200	7.5500	2.5000	.4500
2.5500	7.5700	12.5500	14.4600	18.5300	22.6100	26.6900	
			STATION	22.0000			
0.0000	-4.3500	-6.1600	-4.3400	0.0000	4.3900	6.1600	4.3600
0.0000							
13.6800	11.8800	7.5400	3.1600	1.3800	3.2100	7.5600	11.9000
13.6800							
			STATION	24.0000			
0.0000	-3.2500	-4.5700	-3.2300	0.0000	3.2800	4.6100	3.2500
0.0000							
12.1100	10.7800	7.5400	4.2800	2.9400	4.3100	7.5700	10.7800
12.1100							
			STATION	24.5000			
0.0000	-2.6500	-3.7800	-2.6500	0.0000	2.7000	3.7800	2.6600
0.0000							
11.7400	10.5100	7.5200	4.5200	3.2800	4.5200	7.5200	10.5100
11.7400							
			STATION	25.0000			
0.0000	-2.7390	-3.8740	-2.7390	0.0000	2.7390	3.8740	2.7390
0.0000							
11.3740	10.2400	7.5000	4.7600	3.6260	4.7600	7.5000	10.2400
11.3740							

STATION	BEAM	DRAFT	AREA COEFFICIENT
-1.6000	0.0000	5.6000	.7089
-.8000	0.0000	10.5840	.7071
0.0000	0.0000	12.2300	.7089
1.0000	0.0000	13.5900	.7068
2.0000	2.1200	26.3400	3.1311
3.0000	4.3400	26.5500	1.8257
4.0000	6.0000	26.6600	1.4655
6.0000	7.1200	26.6400	1.3154
8.0000	7.2400	26.6400	1.3013
10.0000	7.2400	26.6400	1.3013
12.0000	7.2400	26.6400	1.3013
14.0000	7.2400	26.6400	1.3013
16.0000	7.2200	26.7000	1.3032
18.0000	6.2200	26.6800	1.4244
20.0000	2.8600	26.2400	2.3867
22.0000	0.0000	12.3000	.7089
24.0000	0.0000	9.1700	.7087
24.5000	0.0000	8.4600	.6314
25.0000	0.0000	7.7480	.7072

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CRITICAL ENC. FREQ. FOR STATION -1.6000 =   0.0000
CRITICAL ENC. FREQ. FOR STATION  -.8000 =   0.0000
CRITICAL ENC. FREQ. FOR STATION  0.0000 =   0.0000
CRITICAL ENC. FREQ. FOR STATION  1.0000 =   0.0000
CRITICAL ENC. FREQ. FOR STATION  2.0000 =  16.2475
CRITICAL ENC. FREQ. FOR STATION  3.0000 =  11.3556
CRITICAL ENC. FREQ. FOR STATION  4.0000 =   9.6578
CRITICAL ENC. FREQ. FOR STATION  6.0000 =   8.8658
CRITICAL ENC. FREQ. FOR STATION  8.0000 =   8.7920
CRITICAL ENC. FREQ. FOR STATION 10.0000 =   8.7920
CRITICAL ENC. FREQ. FOR STATION 12.0000 =   8.7920
CRITICAL ENC. FREQ. FOR STATION 14.0000 =   8.7920
CRITICAL ENC. FREQ. FOR STATION 16.0000 =   8.8041
CRITICAL ENC. FREQ. FOR STATION 18.0000 =   9.4855
CRITICAL ENC. FREQ. FOR STATION 20.0000 =  13.9885
CRITICAL ENC. FREQ. FOR STATION 22.0000 =   0.0000
CRITICAL ENC. FREQ. FOR STATION 24.0000 =   0.0000
CRITICAL ENC. FREQ. FOR STATION 24.5000 =   0.0000
CRITICAL ENC. FREQ. FOR STATION 25.0000 =   0.0000

MINIMUM CRITICAL ENC. FREQ. =    0.0000 DUE TO STATION 25.0000
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                    ***DATA FOR ONE HULL***

   LENGTH BETWEEN PERPENDICULARS =  178.14000 FEET
                BEAM AT MIDSHIP =    7.24000 FEET
               DRAFT AT MIDSHIP =   26.64000 FEET
                   DISPLACEMENT =   1289.648 LONG TONS
              BLOCK COEFFICIENT =    1.34741
 LONGITUDINAL CENTER OF BUOYANCY =  100.37494 FEET   AFT OF F.P.
 LONGITUDINAL CENTER OF BUOYANCY =   11.26922 STATIONS
LONGITUDINAL CENTER OF FLOTATION =   99.66327 FEET   AFT OF F.P.
LONGITUDINAL CENTER OF FLOTATION =   11.18932 STATIONS
     VERTICAL CENTER OF BUOYANCY =   15.46576 FEET   FROM THE DESIGNED LOAD WATERLINE
                     BEAM/DRAFT =     .27177
                    LENGTH/BEAM =   24.60497

 THE HEAVE-HEAVE RESTORING COEFFICIENT IS     4.12036
 THE HEAVE-PITCH RESTORING COEFFICIENT IS     -.01646
 THE PITCH-PITCH RESTORING COEFFICIENT IS      .12559

 PROJECTED AREA OF THE SUBMERGED HULL/L**2 =     .103721E+00
MOMENT/L**3 =    .101487E-02     MOMENT OF INERTIA/L**4 =     .135252E-01
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HULL SEPARATION/BEAM = 9.3591

DYNAMIC COEFFICIENTS OF THE EQUATIONS OF MOTION

A22 IS SCALED BY M.

A24, A26 AND A62 ARE SCALED BY M*L.

A44, A46, A64 AND A66 ARE SCALED BY M*L*L.

B22 IS SCALED BY M*SQRT(G/L).

B24, B26 AND B62 ARE SCALED BY M*SQRT(G*L).

B44, B46, B64, AND B66 ARE SCALED BY M*L*SQRT(G*L).

B44* IS B44 EXCLUDING CROSS-FLOW DRAG CONTRIBUTIONS.

M IS THE DISPLACED MASS.

G IS THE ACCELERATION DUE TO GRAVITY.

L IS THE DISTANCE BETWEEN PERPENDICULARS.

FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT(G*L).

BETA IS THE WAVE HEADING ANGLE IN DEGREES.
BETA = 180. FOR HEAD SEAS.

OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED BY SQRT(G/L).

THE HULL SEPARATION/BEAM RATIO IS THE DISTANCE
BETWEEN THE HULLS DIVIDED BY THE BEAM OF ONE HULL.

HULL SEPARATION/BEAM = 9.3591

BARE HULL POTENTIAL FLOW ADDED MASS COEFFICIENTS
FN = 0.000

OMEGA	A22	A24=A42	A26	A62	A44	A46	A64	A66
.9000	5.258523	.321001	.018301	.018301	.049546	.000970	.000970	.426780
1.0000	5.409902	.329937	.018988	.018988	.050080	.001027	.001027	.438079
1.2000	5.612932	.345314	.019817	.019817	.051197	.001117	.001117	.453663
1.3000	5.611019	.348899	.019699	.019699	.051653	.001128	.001128	.453981
1.4000	5.515288	.347954	.019108	.019108	.051936	.001103	.001103	.447376
1.5000	5.330297	.342041	.018074	.018074	.051990	.001038	.001038	.434059
1.6000	5.082882	.331874	.016735	.016735	.051804	.000938	.000938	.415930
1.7000	4.813582	.319096	.015301	.015301	.051416	.000814	.000814	.396004
1.8000	4.563399	.305696	.013983	.013983	.050895	.000682	.000682	.377429
1.9000	4.364771	.293486	.012950	.012950	.050316	.000554	.000554	.362772
2.0000	4.240032	.283897	.012317	.012317	.049750	.000442	.000442	.353877
2.2000	4.278566	.277176	.012581	.012581	.048925	.000287	.000287	.359200
2.4000	4.885033	.297754	.015752	.015752	.049189	.000254	.000254	.411984
2.7000	9.943598	.527317	.039234	.039234	.059773	.000634	.000634	.889585
3.0000	-11.275885	-.526275	-.078144	-.078144	.001274	-.003483	-.003483	-.646136
3.5000	-.843749	-.001904	-.013342	-.013342	.030396	-.000855	-.000855	-.018987

BARE HULL POTENTIAL FLOW DAMPING COEFFICIENTS
FN = 0.000

OMEGA	B22	B24=B42	B26	B62	B44	B46	B64	B66
.9000	.322224	.012289	.001633	.001633	.000428	.000092	.000092	.023481
1.0000	.551575	.021941	.002776	.002776	.000803	.000164	.000164	.040201
1.2000	1.338374	.058024	.006640	.006640	.002353	.000430	.000430	.097802
1.3000	1.899193	.085961	.009351	.009351	.003676	.000635	.000635	.139124
1.4000	2.529807	.119485	.012354	.012354	.005395	.000880	.000880	.185860
1.5000	3.166142	.155922	.015319	.015319	.007441	.001144	.001144	.233287
1.6000	3.737662	.191714	.017878	.017878	.009684	.001399	.001399	.276042
1.7000	4.190445	.223563	.019750	.019750	.011967	.001618	.001618	.309873
1.8000	4.499727	.249297	.020799	.020799	.014158	.001783	.001783	.332680
1.9000	4.667420	.268038	.021025	.021025	.016163	.001886	.001886	.344407
2.0000	4.711025	.279838	.020511	.020511	.017923	.001925	.001925	.346243
2.2000	4.510254	.284522	.017637	.017637	.020530	.001823	.001823	.326325
2.4000	4.008212	.265660	.012456	.012456	.021505	.001486	.001486	.280737
2.7000	2.252460	.156744	.000293	.000293	.016560	-.000036	-.000036	.122322
3.0000	8.845831	.544653	.090178	.090178	.037472	.005984	.005984	.639136
3.5000	4.031265	.269785	.024853	.024853	.018029	.002366	.002366	.328503

HULL SEPARATION/BEAM = 9.3591

BARE HULL POTENTIAL FLOW ADDED MASS COEFFICIENTS
FN = .446

OMEGA	A22	A24=A42	A26	A62	A44	A46	A64	A66
.9000	5.258523	.321001	.195723	-.159121	.049546	.007736	-.005797	1.718143
1.0000	5.409902	.329937	.264991	-.227014	.050080	.010812	-.008759	1.514196
1.2000	5.612932	.345314	.434341	-.394707	.051197	.019088	-.016855	1.229012
1.3000	5.611019	.348899	.520906	-.481508	.051653	.023813	-.021558	1.114408
1.4000	5.515288	.347954	.594769	-.556552	.051936	.028292	-.026086	1.007111
1.5000	5.330297	.342041	.645674	-.609526	.051990	.031945	-.029869	.905296
1.6000	5.082882	.331874	.667906	-.634435	.051804	.034338	-.032463	.810878
1.7000	4.813582	.319096	.661992	-.631391	.051416	.035315	-.033688	.727319
1.8000	4.563399	.305696	.633389	-.605424	.050895	.034999	-.033635	.657593
1.9000	4.364771	.293486	.589589	-.563690	.050316	.033669	-.032561	.603277
2.0000	4.240032	.283897	.537596	-.512962	.049750	.031644	-.030760	.564730
2.2000	4.278566	.277176	.428195	-.403034	.048925	.026505	-.025932	.535042
2.4000	4.885033	.297754	.326110	-.294606	.049189	.020825	-.020316	.580684
2.7000	9.943598	.527317	.177039	-.098571	.059773	.010224	-.008955	1.160907
3.0000	-11.275885	-.526275	.360216	-.516505	.001274	.023507	-.030474	-.895353
3.5000	-.843749	-.001904	.133429	-.160113	.030396	.008968	-.010677	-.032688

BARE HULL POTENTIAL FLOW DAMPING COEFFICIENTS
FN = .446

OMEGA	B22	B24=B42	B26	B62	B44	B46	B64	B66
.9000	.322224	.012289	-2.343669	2.346934	.000428	-.143074	.143259	.102611
1.0000	.551575	.021941	-2.410040	2.415593	.000803	-.146988	.147316	.149918
1.2000	1.338374	.058024	-2.496727	2.510008	.002353	-.153580	.154440	.282679
1.3000	1.899193	.085961	-2.493164	2.511865	.003676	-.154974	.156244	.362662
1.4000	2.529807	.119485	-2.447464	2.472172	.005395	-.154308	.156067	.442604
1.5000	3.166142	.155922	-2.361994	2.392631	.007441	-.151407	.153694	.513196
1.6000	3.737662	.191714	-2.249087	2.284844	.009684	-.146617	.149415	.566464
1.7000	4.190445	.223563	-2.127108	2.166608	.011967	-.140699	.143935	.598298
1.8000	4.499727	.249297	-2.014478	2.056075	.014158	-.134557	.138123	.608935
1.9000	4.667420	.268038	-1.925663	1.967713	.016163	-.129009	.132780	.601588
2.0000	4.711025	.279838	-1.870543	1.911566	.017923	-.124693	.128542	.580517
2.2000	4.510254	.284522	-1.890604	1.925877	.020530	-.121797	.125444	.511689
2.4000	4.008212	.265660	-2.166269	2.191180	.021505	-.131313	.134284	.419157
2.7000	2.252460	.156744	-4.434552	4.435137	.016560	-.235220	.235147	.183783
3.0000	8.845831	.544653	5.119223	-4.938867	.037472	.240703	-.228735	.834644
3.5000	4.031265	.269785	.401165	-.351459	.018029	.003215	.001517	.393963

HULL SEPARATION/BEAM = 9.3591

ADDED MASS COEFFICIENTS
FN = 0.000

OMEGA	A22	A24=A42	A26	A62	A44	A46	A64	A66
.9000	5.258523	.321001	.018301	.018301	.051143	.000970	.000970	.426780
1.0000	5.409902	.329937	.018988	.018988	.051677	.001027	.001027	.438079
1.2000	5.612932	.345314	.019817	.019817	.052794	.001117	.001117	.453663
1.3000	5.611019	.348899	.019699	.019699	.053250	.001128	.001128	.453981
1.4000	5.515288	.347954	.019108	.019108	.053533	.001103	.001103	.447376
1.5000	5.330297	.342041	.018074	.018074	.053587	.001038	.001038	.434059
1.6000	5.082882	.331874	.016735	.016735	.053401	.000938	.000938	.415930
1.7000	4.813582	.319096	.015301	.015301	.053013	.000814	.000814	.396004
1.8000	4.563399	.305696	.013983	.013983	.052492	.000682	.000682	.377429
1.9000	4.364771	.293486	.012950	.012950	.051913	.000554	.000554	.362772
2.0000	4.240032	.283897	.012317	.012317	.051347	.000442	.000442	.353877
2.2000	4.278566	.277176	.012581	.012581	.050522	.000287	.000287	.359200
2.4000	4.885033	.297754	.015752	.015752	.050786	.000254	.000254	.411984
2.7000	9.943598	.527317	.039234	.039234	.061370	.000634	.000634	.889585
3.0000	-11.275885	-.526275	-.078144	-.078144	.002871	-.003483	-.003483	-.646136
3.5000	-.843749	-.001904	-.013342	-.013342	.031993	-.000855	-.000855	-.018987

DAMPING COEFFICIENTS
FN = 0.000

OMEGA	B22	B24=B42	B44 BETA = 90.0	B44 BETA = 135.0	B66	B26	B62	B46	B64	B44*
.9000	.322224	.012289	.001056	.001049	.023481	.001633	.001633	.000092	.000092	.000428
1.0000	.551575	.021941	.001439	.001449	.040201	.002776	.002776	.000164	.000164	.000803
1.2000	1.338374	.058024	.003072	.003084	.097802	.006640	.006640	.000430	.000430	.002353
1.3000	1.899193	.085961	.004433	.004445	.139124	.009351	.009351	.000635	.000635	.003676
1.4000	2.529807	.119485	.006183	.006197	.185860	.012354	.012354	.000880	.000880	.005395
1.5000	3.166142	.155922	.008256	.008273	.233287	.015319	.015319	.001144	.001144	.007441
1.6000	3.737662	.191714	.010517	.010540	.276042	.017878	.017878	.001399	.001399	.009684
1.7000	4.190445	.223563	.012812	.012844	.309873	.019750	.019750	.001618	.001618	.011967
1.8000	4.499727	.249297	.015008	.015052	.332680	.020799	.020799	.001783	.001783	.014158
1.9000	4.667420	.268038	.017011	.017071	.344407	.021025	.021025	.001886	.001886	.016163
2.0000	4.711025	.279838	.018764	.018844	.346243	.020511	.020511	.001925	.001925	.017923
2.2000	4.510254	.284522	.021344	.021482	.326325	.017637	.017637	.001823	.001823	.020530
2.4000	4.008212	.265660	.022287	.022491	.280737	.012456	.012456	.001486	.001486	.021505
2.7000	2.252460	.156744	.017326	.017546	.122322	.000293	.000293	-.000036	-.000036	.016560
3.0000	8.845831	.544653	.038250	.038396	.639136	.090178	.090178	.005984	.005984	.037472
3.5000	4.031265	.269785	.018892	.018799	.328503	.024853	.024853	.002366	.002366	.018029

HULL SEPARATION/BEAM = 9.3591

ADDED MASS COEFFICIENTS
FN = .446

OMEGA	A22	A24=A42	A26	A62	A44	A46	A64	A66
.9000	5.258523	.321001	.369861	-.159121	.051143	.021608	-.005797	1.717257
1.0000	5.409902	.329937	.406042	-.227014	.051677	.022049	-.008759	1.513478
1.2000	5.612932	.345314	.532294	-.394707	.052794	.026891	-.016855	1.228513
1.3000	5.611019	.348899	.604368	-.481508	.053250	.030462	-.021558	1.113984
1.4000	5.515288	.347954	.666733	-.556552	.053533	.034025	-.026086	1.006744
1.5000	5.330297	.342041	.708363	-.609526	.053587	.036939	-.029869	.904977
1.6000	5.082882	.331874	.723004	-.634435	.053401	.038727	-.032463	.810598
1.7000	4.813582	.319096	.710799	-.631391	.053013	.039203	-.033688	.727070
1.8000	4.563399	.305696	.676924	-.605424	.052492	.038467	-.033635	.657372
1.9000	4.364771	.293486	.628662	-.563690	.051913	.036782	-.032561	.603078
2.0000	4.240032	.283897	.572859	-.512962	.051347	.034453	-.030760	.564550
2.2000	4.278566	.277176	.457338	-.403034	.050522	.028826	-.025932	.534893
2.4000	4.885033	.297754	.350598	-.294606	.050786	.022775	-.020316	.580559
2.7000	9.943598	.527317	.196387	-.098571	.061370	.011765	-.008955	1.160809
3.0000	-11.275885	-.526275	.375888	-.516505	.002871	.024756	-.030474	-.895433
3.5000	-.843749	-.001904	.144944	-.160113	.031993	.009885	-.010677	-.032747

DAMPING COEFFICIENTS
FN = .446

OMEGA	B22	B24=B42	B44 BETA = 90.0	B44 BETA = 135.0	B66	B26	B62	B46	B64	B44*
.9000	.638483	.037483	.052043	.051962	.137414	-2.345278	2.345325	-.143291	.143042	.051471
1.0000	.867833	.047135	.052473	.052374	.184722	-2.411649	2.413984	-.147205	.147099	.051846
1.2000	1.654632	.083217	.054118	.053991	.317483	-2.498337	2.508399	-.153796	.154223	.053396
1.3000	2.215452	.111154	.055480	.055345	.397466	-2.494773	2.510256	-.155190	.156027	.054719
1.4000	2.846066	.144679	.057232	.057092	.477408	-2.449073	2.470563	-.154524	.155851	.056438
1.5000	3.482401	.181116	.059305	.059165	.548000	-2.363603	2.391022	-.151623	.153478	.058485
1.6000	4.053921	.216907	.061567	.061431	.601268	-2.250696	2.283235	-.146834	.149198	.060727
1.7000	4.506703	.248757	.063862	.063737	.633101	-2.128717	2.164999	-.140915	.143719	.063011
1.8000	4.815985	.274491	.066058	.065948	.643739	-2.016087	2.054466	-.134774	.137907	.065201
1.9000	4.983679	.293232	.068061	.067972	.636392	-1.927272	1.966104	-.129225	.132564	.067206
2.0000	5.027284	.305031	.069814	.069750	.615321	-1.872152	1.909956	-.124910	.128326	.068967
2.2000	4.826513	.309715	.072391	.072386	.546493	-1.892213	1.924268	-.122013	.125228	.071574
2.4000	4.324470	.290853	.073331	.073385	.453960	-2.167878	2.189571	-.131529	.134068	.072548
2.7000	2.568719	.181937	.068363	.068462	.218586	-4.436161	4.433528	-.235436	.234931	.067604
3.0000	9.162090	.569846	.089284	.089414	.869448	5.117614	-4.940476	.240486	-.228951	.088515
3.5000	4.347523	.294979	.069884	.070025	.428767	.399556	-.353068	.002999	.001300	.069072

HULL SEPARATION/BEAM = 9.3591

EXCITING FORCE, MOMENTS AND PHASES

THE SWAY FORCE IS SCALED BY M*G*A.

THE ROLL AND YAW MOMENTS ARE SCALED BY M*G*A.

*MOMENT DENOTES THE MOMENT SCALED BY M*G*A*(WAVE NUMBER).

M IS THE DISPLACED MASS.

G IS THE ACCELERATION DUE TO GRAVITY.

A IS THE WAVE AMPLITUDE.

L IS THE DISTANCE BETWEEN PERPENDICULARS.

FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT(G*L).

BETA IS THE WAVE HEADING ANGLE IN DEGREES.
BETA = 180. FOR HEAD SEAS.

OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED BY SQRT(G/L).

THE PHASE ANGLE IS MEASURED IN DEGREES WITH RESPECT
TO THE WAVE AT THE CG.

L/LAM = L/(WAVE LENGTH).

FOR FOLLOWING SEAS THE FREQUENCY DOMAIN IS DIVIDED INTO THREE
REGIONS SEPARATED BY TWO CRITICAL SWR, DENOTED CWR1 AND CWR2.

HULL SEPARATION/BEAM = 9.3591

EXCITING FORCE, MOMENTS AND PHASES
FN = 0.000
BETA = 90.0

OMEGA	L/LAM	SFORCE	PHASE	RMOMENT	PHASE	*MOMENT	YMOMENT	PHASE	*MOMENT	LAM/L
.9000	.1289	4.72318	-93.207	.19614	-92.540	.24214	.01392	-95.550	.01719	7.7570
1.0000	.1592	5.85833	-94.801	.25357	-93.778	.25357	.01763	-98.110	.01763	6.2832
1.2000	.2292	8.32181	-99.277	.39328	-97.337	.27311	.02601	-105.054	.01806	4.3633
1.3000	.2690	9.52180	-102.027	.47143	-99.544	.27896	.03021	-109.262	.01787	3.7179
1.4000	.3119	10.58886	-104.889	.55025	-101.843	.28074	.03395	-113.687	.01732	3.2057
1.5000	.3581	11.44485	-107.609	.62537	-104.014	.27794	.03690	-118.018	.01640	2.7925
1.6000	.4074	12.04098	-109.914	.69308	-105.829	.27074	.03878	-121.902	.01515	2.4544
1.7000	.4600	12.36785	-111.571	.75111	-107.104	.25990	.03951	-125.001	.01367	2.1741
1.8000	.5157	12.44916	-112.427	.79870	-107.731	.24651	.03914	-127.019	.01208	1.9393
1.9000	.5745	12.32608	-112.411	.83605	-107.686	.23159	.03784	-127.722	.01048	1.7405
2.0000	.6366	12.04196	-111.516	.86367	-107.000	.21592	.03585	-126.924	.00896	1.5708
2.2000	.7703	11.12228	-107.233	.89041	-103.964	.18397	.03075	-120.336	.00635	1.2982
2.4000	.9167	9.82280	-99.912	.87491	-99.135	.15189	.02499	-107.442	.00434	1.0908
2.7000	1.1602	6.06824	-82.865	.70155	-89.697	.09623	.00500	51.929	.00069	.8619
3.0000	1.4324	13.18741	-60.890	1.00687	-69.071	.11187	.12055	-62.902	.01339	.6981
3.5000	1.9496	7.88661	-14.846	.54051	-23.775	.04412	.07070	-51.240	.00577	.5129

EXCITING FORCE, MOMENTS AND PHASES
FN = .446
BETA = 90.0

OMEGA	L/LAM	SFORCE	PHASE	RMOMENT	PHASE	*MOMENT	YMOMENT	PHASE	*MOMENT	LAM/L
.9000	.1289	4.72480	-93.540	.19768	-97.071	.24405	1.97321	176.598	2.43606	7.7570
1.0000	.1592	5.86091	-95.092	.25589	-98.354	.25589	2.21552	174.789	2.21552	6.2832
1.2000	.2292	8.32733	-99.507	.39876	-101.956	.27691	2.65097	169.711	1.84095	4.3633
1.3000	.2690	9.52920	-102.234	.47956	-104.197	.28376	2.81198	166.590	1.66390	3.7179
1.4000	.3119	10.59823	-105.079	.56181	-106.560	.28664	2.91303	163.329	1.48624	3.2057
1.5000	.3581	11.45605	-107.785	.64104	-108.839	.28491	2.94408	160.208	1.30848	2.7925
1.6000	.4074	12.05362	-110.079	.71327	-110.815	.27862	2.90501	157.530	1.13477	2.4544
1.7000	.4600	12.38134	-111.728	.77588	-112.311	.26847	2.80553	155.564	.97077	2.1741
1.8000	.5157	12.46278	-112.578	.82772	-113.224	.25547	2.66130	154.504	.82139	1.9393
1.9000	.5745	12.33910	-112.557	.86864	-113.526	.24062	2.48931	154.462	.68956	1.7405
2.0000	.6366	12.05370	-111.657	.89883	-113.248	.22471	2.30434	155.483	.57608	1.5708
2.2000	.7703	11.12995	-107.359	.92684	-111.211	.19150	1.93621	160.653	.40004	1.2982
2.4000	.9167	9.82582	-100.012	.90658	-107.669	.15739	1.60039	169.547	.27785	1.0908
2.7000	1.1602	6.06801	-82.882	.71718	-101.983	.09838	.97533	-172.899	.13379	.8619
3.0000	1.4324	13.19485	-60.832	.96207	-77.840	.10690	2.14390	-150.335	.23821	.6981
3.5000	1.9496	7.92188	-14.779	.42083	-31.228	.03435	1.25088	-124.848	.10211	.5129

HULL SEPARATION/BEAM = 9.3591

EXCITING FORCE, MOMENTS AND PHASES
FN = 0.000
BETA = 135.0

OMEGA	L/LAM	SFORCE	PHASE	RMOMENT	PHASE	*MOMENT	YMOMENT	PHASE	*MOMENT	LAM/L
.9000	.1289	3.32058	-93.123	.13734	-92.672	.16956	.16067	-6.268	.19836	7.7570
1.0000	.1592	4.10690	-94.707	.17660	-93.893	.17660	.24483	-7.079	.24483	6.2832
1.2000	.2292	5.78365	-99.205	.26922	-97.499	.18696	.49700	-10.319	.34514	4.3633
1.3000	.2690	6.57658	-102.005	.31853	-99.792	.18848	.66586	-12.585	.39400	3.7179
1.4000	.3119	7.25631	-104.960	.36545	-102.249	.18646	.85779	-15.074	.43765	3.2057
1.5000	.3581	7.76592	-107.829	.40610	-104.675	.18049	1.06413	-17.554	.47295	2.7925
1.6000	.4074	8.07071	-110.350	.43701	-106.864	.17071	1.27448	-19.781	.49785	2.4544
1.7000	.4600	8.16516	-112.304	.45575	-108.648	.15770	1.47911	-21.544	.51180	2.1741
1.8000	.5157	8.06856	-113.542	.46105	-109.922	.14230	1.67050	-22.704	.51562	1.9393
1.9000	.5745	7.81435	-113.993	.45253	-110.636	.12535	1.84432	-23.189	.51089	1.7405
2.0000	.6366	7.44021	-113.649	.43049	-110.773	.10762	1.99817	-22.980	.49954	1.5708
2.2000	.7703	6.47436	-110.696	.35020	-109.119	.07236	2.25108	-20.481	.46510	1.2982
2.4000	.9167	5.42728	-105.171	.23783	-103.512	.04129	2.48583	-15.170	.43157	1.0908
2.7000	1.1602	3.97770	-96.602	.09183	-77.151	.01260	3.77133	-2.326	.51733	.8619
3.0000	1.4324	3.20539	-266.045	.41880	85.596	.04653	2.00860	-166.593	.22318	.6981
3.5000	1.9496	.35328	-216.050	.08258	104.701	.00674	.07611	65.858	.00621	.5129

EXCITING FORCE, MOMENTS AND PHASES
FN = .446
BETA = 135.0

OMEGA	L/LAM	SFORCE	PHASE	RMOMENT	PHASE	*MOMENT	YMOMENT	PHASE	*MOMENT	LAM/L
.9000	.0851	2.70335	-93.754	.11621	-96.028	.21728	1.07707	176.667	2.01381	11.7478
1.0000	.1015	3.32640	-95.356	.14721	-97.192	.23072	1.17105	174.801	1.83537	9.8475
1.2000	.1371	4.70553	-99.995	.22139	-100.816	.25693	1.30838	169.409	1.51844	7.2919
1.3000	.1562	5.40857	-102.912	.26285	-103.232	.26788	1.33734	165.978	1.36295	6.4035
1.4000	.1759	6.07239	-106.007	.30513	-105.893	.27604	1.33143	162.261	1.20446	5.6840
1.5000	.1964	6.66324	-109.028	.34639	-108.592	.28071	1.28855	158.504	1.04423	5.0918
1.6000	.2175	7.16191	-111.705	.38509	-111.100	.28179	1.21150	154.968	.88651	4.5977
1.7000	.2392	7.56978	-113.806	.42051	-113.208	.27977	1.10712	151.874	.73658	4.1803
1.8000	.2615	7.90707	-115.175	.45277	-114.773	.27556	.98393	149.356	.59884	3.8240
1.9000	.2843	8.20686	-115.737	.48275	-115.714	.27022	.84986	147.449	.47571	3.5171
2.0000	.3077	8.50960	-115.484	.51183	-115.999	.26477	.71073	146.074	.36766	3.2503
2.2000	.3557	9.32177	-112.678	.57563	-114.554	.25752	.42786	143.645	.19142	2.8110
2.4000	.4056	10.94506	-107.152	.67332	-110.271	.26422	.13668	122.615	.05364	2.4656
2.7000	.4832	21.52646	-94.689	1.23162	-97.400	.40564	1.07886	.372	.35533	2.0694
3.0000	.5640	26.59696	-254.249	1.44771	108.947	.40854	.21820	-64.414	.06158	1.7731
3.5000	.7045	3.03367	-208.947	.19896	163.886	.04495	.55724	-54.570	.12588	1.4194

HULL SEPARATION/BEAM = 9.3591

MOTION AMPLITUDES AND PHASES

THE SWAY AMPLITUDE IS SCALED BY A.

THE ROLL AMPLITUDE IS SCALED BY 2*A/B.

THE YAW AMPLITUDE IS SCALED BY 2*A/L.

ROLL DENOTES ROLL AMPLITUDE SCALED BY A(WAVE NUMBER).

YAW DENOTES YAW AMPLITUDE SCALED BY A(WAVE NUMBER).

A IS THE WAVE AMPLITUDE.

B IS THE TOTAL HULL SEPARATION FOR TWIN-HULL SHIPS.

B IS THE BEAM AT MIDSHIP FOR MONO-HULL SHIPS.

L IS THE DISTANCE BETWEEN PERPENDICULARS.

FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT(G*L).

BETA IS THE WAVE HEADING ANGLE IN DEGREES.
BETA = 180. FOR HEAD SEAS.

OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED BY SQRT(G/L).

THE PHASE ANGLE IS MEASURED IN DEGREES WITH RESPECT TO THE WAVE AT THE CG.

L/LAM = L/(WAVE LENGTH).

FOR FOLLOWING SEAS THE FREQUENCY IS DIVIDED INTO THREE
REGIONS SEPARATED BY TWO CRITICAL SWR, DENOTED CWR1 AND CWR2.

HULL SEPARATION/BEAM = 9.3591

MOTION AMPLITUDES AND PHASES
FN = 0.000
BETA = 90.0

OMEGA	L/LAM	SWAY	PHASE	ROLL	PHASE	*ROLL	YAW	PHASE	*YAW	LAM/L
.9000	.1289	.99800	89.953	.32024	-92.085	1.87814	.00030	84.433	.00074	7.7570
1.0000	.1592	.92678	89.859	.07836	-104.921	.37223	.00020	86.856	.00041	6.2832
1.2000	.2292	.85267	89.919	.04902	121.493	.16172	.00026	95.564	.00036	4.3633
1.3000	.2690	.81518	89.998	.08215	110.154	.23092	.00030	100.069	.00035	3.7179
1.4000	.3119	.77487	-269.863	.11208	105.545	.27165	.00034	104.839	.00035	3.2057
1.5000	.3581	.73146	-269.644	.13892	102.604	.29331	.00039	109.674	.00035	2.7925
1.6000	.4074	.68503	-269.325	.16241	100.296	.30137	.00044	114.125	.00034	2.4544
1.7000	.4600	.63582	-268.895	.18210	98.354	.29932	.00049	117.726	.00034	2.1741
1.8000	.5157	.58410	-268.345	.19765	96.708	.28979	.00054	120.197	.00033	1.9393
1.9000	.5745	.53016	-267.668	.20890	95.334	.27489	.00057	121.485	.00031	1.7405
2.0000	.6366	.47425	-266.859	.21583	94.205	.25632	.00057	121.651	.00028	1.5708
2.2000	.7703	.35759	-264.780	.21705	92.540	.21303	.00043	118.615	.00018	1.2982
2.4000	.9167	.23610	-261.844	.20231	91.397	.16685	.00003	56.257	.00001	1.0908
2.7000	1.1602	.04502	-248.187	.15391	89.622	.10029	.00134	-82.286	.00037	.8619
3.0000	1.4324	.16133	-78.933	.09382	88.045	.04952	.00177	-117.981	.00039	.6981
3.5000	1.9496	.53697	-111.114	.05910	-114.130	.02292	.01873	-74.151	.00306	.5129

MOTION AMPLITUDES AND PHASES
FN = .446
BETA = 90.0

OMEGA	L/LAM	SWAY	PHASE	ROLL	PHASE	*ROLL	YAW	PHASE	*YAW	LAM/L
.9000	.1289	.92553	-262.431	.07193	-16.288	.42186	.07337	-76.885	.18115	7.7570
1.0000	.1592	.90296	-263.883	.04050	-19.069	.19239	.06327	-75.622	.12653	6.2832
1.2000	.2292	.84467	-265.779	.03350	99.417	.11051	.04694	-76.322	.06519	4.3633
1.3000	.2690	.80940	-266.345	.06349	107.088	.17847	.04038	-77.309	.04778	3.7179
1.4000	.3119	.77027	-266.707	.09289	107.386	.22514	.03482	-78.725	.03553	3.2057
1.5000	.3581	.72754	-266.878	.12059	105.990	.25460	.03007	-80.791	.02672	2.7925
1.6000	.4074	.68154	-266.865	.14574	104.019	.27043	.02590	-83.756	.02024	2.4544
1.7000	.4600	.63267	-266.673	.16752	101.872	.27536	.02213	-87.836	.01531	2.1741
1.8000	.5157	.58129	-266.307	.18534	99.749	.27174	.01859	-93.221	.01148	1.9393
1.9000	.5745	.52774	-265.771	.19885	97.749	.26166	.01524	-100.117	.00845	1.7405
2.0000	.6366	.47228	-265.066	.20795	95.902	.24696	.01208	-108.838	.00604	1.5708
2.2000	.7703	.35657	-263.104	.21317	92.600	.20922	.00660	-134.382	.00273	1.2982
2.4000	.9167	.23591	-260.096	.20214	89.477	.16671	.00306	-178.256	.00106	1.0908
2.7000	1.1602	.04622	-242.173	.15962	83.315	.10401	.00051	-156.657	.00014	.8619
3.0000	1.4324	.16293	-82.295	.10516	73.282	.05550	.00417	-37.666	.00093	.6981
3.5000	1.9496	.47361	-110.513	.04298	-65.181	.01667	.10786	175.010	.01761	.5129

HULL SEPARATION/BEAM = 9.3591

MOTION AMPLITUDES AND PHASES
FN = 0.000
BETA = 135.0

OMEGA	L/LAM	SWAY	PHASE	ROLL	PHASE	*ROLL	YAW	PHASE	*YAW	LAM/L
.9000	.1289	.70414	-269.836	.23719	-88.881	1.39102	.18852	179.993	.46548	7.7570
1.0000	.1592	.65168	89.937	.06334	-97.844	.30087	.22769	-179.951	.45538	6.2832
1.2000	.2292	.59542	89.865	.02153	135.169	.07104	.30995	-179.900	.43049	4.3633
1.3000	.2690	.56667	89.837	.03982	117.011	.11193	.35113	-179.899	.41554	3.7179
1.4000	.3119	.53571	89.812	.05510	111.649	.13355	.39084	-179.932	.39882	3.2057
1.5000	.3581	.50236	89.790	.06680	108.977	.14104	.42777	179.983	.38024	2.7925
1.6000	.4074	.46675	89.769	.07459	107.310	.13840	.46043	179.830	.35971	2.4544
1.7000	.4600	.42914	89.741	.07811	106.277	.12839	.48723	179.597	.33718	2.1741
1.8000	.5157	.38993	89.695	.07722	105.882	.11322	.50651	179.284	.31266	1.9393
1.9000	.5745	.34958	89.618	.07207	106.313	.09483	.51672	178.908	.28627	1.7405
2.0000	.6366	.30865	89.501	.06311	107.989	.07495	.51662	178.504	.25831	1.5708
2.2000	.7703	.22783	89.105	.03764	120.196	.03694	.48350	177.874	.19979	1.2982
2.4000	.9167	.15334	88.281	.01949	179.753	.01607	.41164	178.061	.14293	1.0908
2.7000	1.1602	.05676	82.095	.03562	-119.574	.02321	.26141	-179.468	.07172	.8619
3.0000	1.4324	.05352	76.260	.07439	-99.789	.03927	.19068	172.904	.04237	.6981
3.5000	1.9496	.02930	49.332	.01149	-73.920	.00445	.02345	-64.965	.00383	.5129

MOTION AMPLITUDES AND PHASES
FN = .446
BETA = 135.0

OMEGA	L/LAM	SWAY	PHASE	ROLL	PHASE	*ROLL	YAW	PHASE	*YAW	LAM/L
.9000	.0851	.56447	-263.857	.01755	-58.880	.15586	.05278	-128.949	.19736	11.7478
1.0000	.1015	.55680	-265.417	.00956	-142.363	.07120	.06239	-146.115	.19557	9.8475
1.2000	.1371	.53773	-267.648	.03167	142.076	.17458	.09343	-165.387	.21687	7.2919
1.3000	.1562	.52652	-268.496	.04281	133.420	.20725	.11063	-170.295	.22549	6.4035
1.4000	.1759	.51422	-269.232	.05307	127.694	.22806	.12771	-173.600	.23106	5.6840
1.5000	.1964	.50091	-269.870	.06250	123.195	.24060	.14428	-175.901	.23385	5.0918
1.6000	.2175	.48673	89.584	.07095	119.296	.24663	.16013	-177.544	.23435	4.5977
1.7000	.2392	.47187	89.131	.07825	115.798	.24731	.17514	-178.734	.23305	4.1803
1.8000	.2615	.45656	88.772	.08429	112.658	.24369	.18923	-179.599	.23034	3.8240
1.9000	.2843	.44103	88.508	.08907	109.886	.23685	.20238	179.783	.22657	3.5171
2.0000	.3077	.42546	88.339	.09271	107.490	.22782	.21459	179.365	.22202	3.2503
2.2000	.3557	.39513	88.302	.09725	103.804	.20669	.23647	179.062	.21159	2.8110
2.4000	.4056	.36750	88.668	.09994	101.508	.18631	.25648	179.476	.20129	2.4656
2.7000	.4832	.33343	89.518	.11440	100.044	.17899	.29437	-178.872	.19390	2.0694
3.0000	.5640	.39733	86.666	.04599	92.314	.06165	.41255	176.281	.23284	1.7731
3.5000	.7045	.21660	44.401	.04558	60.935	.04891	.17938	134.359	.08104	1.4194

MOT246 SWAY, ROLL AND YAW MOTIONS OF SWATH 6A
ABSOLUTE DISPLACEMENT, VELOCITY, AND ACCELERATION AT STATION 1.0 AND HEIGHT 0.0

SPEED = 0.0 KNOTS
WAVE HEADING = 90.0 DEGREES

ENC PER(SEC)	ABS DISPL	VEL	ACCEL/G	WAVE L/L
16.43	.998	.382	.005	7.7570
14.78	.927	.394	.005	6.2832
12.32	.853	.435	.007	4.3633
11.37	.815	.451	.008	3.7179
10.56	.775	.461	.009	3.2057
9.86	.732	.467	.009	2.7925
9.24	.685	.466	.010	2.4544
8.70	.636	.460	.010	2.1741
8.21	.585	.447	.011	1.9393
7.78	.531	.428	.011	1.7405
7.39	.475	.404	.011	1.5708
6.72	.358	.335	.010	1.2982
6.16	.236	.241	.008	1.0908
5.48	.044	.050	.002	.8619
4.93	.163	.207	.008	.6981
4.22	.552	.822	.038	.5129

SPEED = 20.0 KNOTS
WAVE HEADING = 90.0 DEGREES

ENC PER(SEC)	ABS DISPL	VEL	ACCEL/G	WAVE L/L
16.43	.851	.325	.004	7.7570
14.78	.839	.356	.005	6.2832
12.32	.797	.407	.006	4.3633
11.37	.768	.425	.007	3.7179
10.56	.735	.437	.008	3.2057
9.86	.697	.444	.009	2.7925
9.24	.655	.445	.009	2.4544
8.70	.610	.441	.010	2.1741
8.21	.562	.430	.010	1.9393
7.78	.513	.414	.010	1.7405
7.39	.461	.392	.010	1.5708
6.72	.352	.329	.010	1.2982
6.16	.236	.241	.008	1.0908
5.48	.046	.053	.002	.8619
4.93	.166	.212	.008	.6981
4.22	.514	.765	.035	.5129

MOT246 SWAY, ROLL AND YAW MOTIONS OF SWATH 6A
ABSOLUTE DISPLACEMENT, VELOCITY, AND ACCELERATION AT STATION 1.0 AND HEIGHT 0.0

SPEED = 0.0 KNOTS
WAVE HEADING = 135.0 DEGREES

ENC PER(SEC)	ABS DISPL	VEL	ACCEL/G	WAVE L/L
16.43	.731	.280	.003	7.7570
14.78	.692	.294	.004	6.2832
12.32	.674	.344	.005	4.3633
11.37	.670	.370	.006	3.7179
10.56	.668	.397	.007	3.2057
9.86	.666	.425	.008	2.7925
9.24	.664	.452	.010	2.4544
8.70	.660	.477	.011	2.1741
8.21	.652	.499	.012	1.9393
7.78	.639	.516	.013	1.7405
7.39	.618	.526	.014	1.5708
6.72	.551	.515	.015	1.2982
6.16	.450	.459	.015	1.0908
5.48	.266	.305	.011	.8619
4.93	.197	.251	.010	.6981
4.22	.029	.044	.002	.5129

SPEED = 20.0 KNOTS
WAVE HEADING = 135.0 DEGREES

ENC PER(SEC)	ABS DISPL	VEL	ACCEL/G	WAVE L/L
16.43	.528	.202	.002	11.7478
14.78	.528	.225	.003	9.8475
12.32	.526	.268	.004	7.2919
11.37	.523	.289	.005	6.4035
10.56	.518	.308	.006	5.6840
9.86	.512	.327	.006	5.0918
9.24	.506	.344	.007	4.5977
8.70	.499	.360	.008	4.1803
8.21	.491	.376	.009	3.8240
7.78	.483	.390	.010	3.5171
7.39	.476	.404	.011	3.2503
6.72	.461	.431	.013	2.8110
6.16	.449	.458	.015	2.4656
5.48	.444	.509	.018	2.0694
4.93	.583	.743	.029	1.7731
4.22	.284	.423	.020	1.4194

SAMPLE RUN 2 - MOT35 OUTPUT (IG = 3) FOR COMPUTER RUN FOR TWO HEADINGS AND TWO FROUDE NUMBERS

```
MOT35     HEAVE AND PITCH MOTIONS OF   SWATH 6A                                                    PAGE     1

DATA INPUT CARDS
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
 SWATH 6A
   0    1
   0.00000   0.00000
  16    2    2    1    1   19    3    3    0    0
    .90000   1.00000   1.20000   1.30000   1.40000   1.50000   1.60000   1.70000
   1.80000   1.90000   2.00000   2.20000   2.40000   2.70000   3.00000   3.50000
 135.00000 180.00000
   0.00000    .44600
  37.50000
   1.00000
   0.00000
 178.14000    .31500    .22300   0.00000   7.44000  11.06000  19.17000  20.00000
  40.44000  25.75000  19.17000   8.50000  10.20000   1.28000   4.38000   1.20000
 188.12000  23.55000  19.17000  14.70000  17.60000   2.20000   3.43000   1.20000
    .50000    .07000   0.00000   0.00000    0   19
  -1.6000   0.0000    0.0000    0.0000          9         0
   -.8000   0.0000    0.0000    0.0000          9         0
   0.0000   0.0000    0.0000    0.0000          9         0
   1.0000   0.0000    0.0000    0.0000          9         0
   2.0000   0.0000    0.0000    0.0000         15         0
   3.0000   0.0000    0.0000    0.0000         15         0
   4.0000   0.0000    0.0000    0.0000         15         0
   6.0000   0.0000    0.0000    0.0000         15         0
   8.0000   0.0000    0.0000    0.0000         15         2
  10.0000   0.0000    0.0000    0.0000         15         1
  12.0000   0.0000    0.0000    0.0000         15         1
  14.0000   0.0000    0.0000    0.0000         15         1
  16.0000   0.0000    0.0000    0.0000         15         1
  18.0000   0.0000    0.0000    0.0000         15         0
  20.0000   0.0000    0.0000    0.0000         15         0
  22.0000   0.0000    0.0000    0.0000          9         0
  24.0000   0.0000    0.0000    0.0000          9         0
  24.5000   0.0000    0.0000    0.0000          9         0
  25.0000   0.0000    0.0000    0.0000          9         0
```

			STATION	-1.6000			
0.0000	-2.0200	-2.7900	-1.9600	0.0000	1.9800	2.8100	2.0000
0.0000							
10.3100	9.4500	7.5100	5.5000	4.7100	5.5300	7.5300	9.5000
10.3100							
			STATION	-.8000			
0.0000	-3.7420	-5.2920	-3.7420	0.0000	3.7420	5.2920	3.7420
0.0000							
12.7920	11.2420	7.5000	3.7580	2.2080	3.7580	7.5000	11.2420
12.7920							
			STATION	0.0000			
0.0000	-4.3800	-6.1100	-4.3000	0.0000	4.3600	6.1400	4.3300
0.0000							
13.6300	11.7800	7.5000	3.1500	1.4000	3.1900	7.5500	11.8400
13.6300							
			STATION	1.0000			
0.0000	-4.8500	-6.7800	-4.7500	0.0000	4.8200	6.8200	4.8200
0.0000							
14.3200	12.2600	7.5300	2.6800	.7300	2.7100	7.5400	12.3000
14.3200							
			STATION	2.0000			
-1.0600	-1.0600	-1.0600	-1.0600	-5.1600	-7.2400	-5.0700	0.0000
5.1100	7.2300	5.1200	1.0600	1.0600	1.0600	1.0600	
26.6800	22.7200	18.7800	14.6800	12.5900	7.5200	2.3900	.3400
2.4300	7.5600	12.6500	14.6800	18.7800	22.7200	26.6800	
			STATION	3.0000			
-2.1700	-2.1700	-2.1700	-2.1700	-5.3200	-7.4400	-5.2000	0.0000
5.2400	7.4200	5.2400	2.1700	2.1700	2.1700	2.1700	
26.6600	22.6400	18.6400	14.6200	12.7200	7.5200	2.2500	.1100
2.2900	7.5600	12.7900	14.6200	18.6400	22.6400	26.6600	
			STATION	4.0000			
-3.0000	-3.0000	-3.0000	-3.0000	-5.3600	-7.5300	-5.2800	0.0000
5.3100	7.5000	5.3000	3.0000	3.0000	3.0000	3.0000	
26.6600	22.5700	18.4600	14.3700	12.7700	7.5000	2.1800	0.0000
2.2300	7.5600	12.8400	14.3700	18.4600	22.5700	26.6600	
			STATION	6.0000			
-3.5600	-3.5600	-3.5600	-3.5600	-5.3700	-7.5300	-5.2700	0.0000
5.3400	7.5600	5.3700	3.5600	3.5600	3.5600	3.5600	
26.6400	22.4800	18.3200	14.1600	12.7900	7.5200	2.1700	0.0000
2.1800	7.5500	12.8500	14.1600	18.3200	22.4800	26.6400	
			STATION	8.0000			
-3.6200	-3.6200	-3.6200	-3.6200	-5.3700	-7.5300	-5.2700	0.0000
5.3400	7.5600	5.3700	3.6200	3.6200	3.6200	3.6200	
26.6400	22.4600	18.2800	14.1100	12.7900	7.5200	2.1700	0.0000
2.1800	7.5500	12.8500	14.1100	18.2800	22.4600	26.6400	
			STATION	10.0000			
-3.6200	-3.6200	-3.6200	-3.6200	-5.3700	-7.5300	-5.2700	0.0000
5.3400	7.5600	5.3700	3.6200	3.6200	3.6200	3.6200	
26.6400	22.4600	18.2800	14.1100	12.7900	7.5200	2.1700	0.0000
2.1800	7.5500	12.8500	14.1100	18.2800	22.4600	26.6400	

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                                   STATION     12.0000
 -3.6200  -3.6200  -3.6200  -3.6200  -5.3700  -7.5300  -5.2700   0.0000
  5.3400   7.5600   5.3700   3.6200   3.6200   3.6200   3.6200
 26.6400  22.4600  18.2800  14.1100  12.7900   7.5200   2.1700   0.0000
  2.1800   7.5500  12.8500  14.1100  18.2800  22.4600  26.6400
                                   STATION     14.0000
 -3.6200  -3.6200  -3.6200  -3.6200  -5.3700  -7.5300  -5.2700   0.0000
  5.3400   7.5600   5.3700   3.6200   3.6200   3.6200   3.6200
 26.6400  22.4600  18.2800  14.1100  12.7900   7.5200   2.1700   0.0000
  2.1800   7.5500  12.8500  14.1100  18.2800  22.4600  26.6400
                                   STATION     16.0000
 -3.6100  -3.6100  -3.6100  -3.6100  -5.3700  -7.5300  -5.2700   0.0000
  5.3400   7.5600   5.3700   3.6100   3.6100   3.6100   3.6100
 26.7000  22.5200  18.3400  14.1500  12.7900   7.5200   2.1700   0.0000
  2.1800   7.5500  12.8500  14.1500  18.3400  22.5200  26.7000
                                   STATION     18.0000
 -3.1100  -3.1100  -3.1100  -3.1100  -5.3000  -7.4800  -5.2500   0.0000
  5.3300   7.4900   5.2700   3.1100   3.1100   3.1100   3.1100
 26.6800  22.5700  18.4500  14.3400  12.8200   7.5400   2.2400   0.0000
  2.2700   7.5700  12.8200  14.3400  18.4500  22.5700  26.6800
                                   STATION     20.0000
 -1.4300  -1.4300  -1.4300  -1.4300  -5.0100  -7.1000  -4.9800   0.0000
  5.0600   7.1100   5.0100   1.4300   1.4300   1.4300   1.4300
 26.6900  22.6100  18.5300  14.4600  12.5200   7.5500   2.5000    .4500
  2.5500   7.5700  12.5500  14.4600  18.5300  22.6100  26.6900
                                   STATION     22.0000
  0.0000  -4.3500  -6.1600  -4.3400   0.0000   4.3900   6.1600   4.3600
  0.0000
 13.6800  11.8800   7.5400   3.1600   1.3800   3.2100   7.5600  11.9000
 13.6800
                                   STATION     24.0000
  0.0000  -3.2500  -4.5700  -3.2300   0.0000   3.2800   4.6100   3.2500
  0.0000
 12.1100  10.7800   7.5400   4.2800   2.9400   4.3100   7.5700  10.7800
 12.1100
                                   STATION     24.5000
  0.0000  -2.6500  -3.7800  -2.6500   0.0000   2.7000   3.7800   2.6600
  0.0000
 11.7400  10.5100   7.5200   4.5200   3.2800   4.5200   7.5200  10.5100
 11.7400
                                   STATION     25.0000
  0.0000  -2.7390  -3.8740  -2.7390   0.0000   2.7390   3.8740   2.7390
  0.0000
 11.3740  10.2400   7.5000   4.7600   3.6260   4.7600   7.5000  10.2400
 11.3740
```

STATION	BEAM	DRAFT	AREA COEFFICIENT
-1.6000	0.0000	5.6000	.7089
-.8000	0.0000	10.5840	.7071
0.0000	0.0000	12.2300	.7089
1.0000	0.0000	13.5900	.7068
2.0000	2.1200	26.3400	3.1311
3.0000	4.3400	26.5500	1.8257
4.0000	6.0000	26.6600	1.4655
6.0000	7.1200	26.6400	1.3154
8.0000	7.2400	26.6400	1.3013
10.0000	7.2400	26.6400	1.3013
12.0000	7.2400	26.6400	1.3013
14.0000	7.2400	26.6400	1.3013
16.0000	7.2200	26.7000	1.3032
18.0000	6.2200	26.6800	1.4244
20.0000	2.8600	26.2400	2.3867
22.0000	0.0000	12.3000	.7089
24.0000	0.0000	9.1700	.7087
24.5000	0.0000	8.4600	.6314
25.0000	0.0000	7.7480	.7072

CRITICAL ENC. FREQ. FOR STATION -1.6000 = 0.0000
CRITICAL ENC. FREQ. FOR STATION -.8000 = 0.0000
CRITICAL ENC. FREQ. FOR STATION 0.0000 = 0.0000
CRITICAL ENC. FREQ. FOR STATION 1.0000 = 0.0000
CRITICAL ENC. FREQ. FOR STATION 2.0000 = 16.2475
CRITICAL ENC. FREQ. FOR STATION 3.0000 = 11.3556
CRITICAL ENC. FREQ. FOR STATION 4.0000 = 9.6578
CRITICAL ENC. FREQ. FOR STATION 6.0000 = 8.8658
CRITICAL ENC. FREQ. FOR STATION 8.0000 = 8.7920
CRITICAL ENC. FREQ. FOR STATION 10.0000 = 8.7920
CRITICAL ENC. FREQ. FOR STATION 12.0000 = 8.7920
CRITICAL ENC. FREQ. FOR STATION 14.0000 = 8.7920
CRITICAL ENC. FREQ. FOR STATION 16.0000 = 8.8041
CRITICAL ENC. FREQ. FOR STATION 18.0000 = 9.4855
CRITICAL ENC. FREQ. FOR STATION 20.0000 = 13.9885
CRITICAL ENC. FREQ. FOR STATION 22.0000 = 0.0000
CRITICAL ENC. FREQ. FOR STATION 24.0000 = 0.0000
CRITICAL ENC. FREQ. FOR STATION 24.5000 = 0.0000
CRITICAL ENC. FREQ. FOR STATION 25.0000 = 0.0000

MINIMUM CRITICAL ENC. FREQ. = 0.0000 DUE TO STATION 25.0000

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                          ***DATA FOR ONE HULL***

     LENGTH BETWEEN PERPENDICULARS =  178.14000 FEET
                  BEAM AT MIDSHIP =    7.24000 FEET
                 DRAFT AT MIDSHIP =   26.64000 FEET
                     DISPLACEMENT =   1289.648 LONG TONS
                BLOCK COEFFICIENT =    1.34741
   LONGITUDINAL CENTER OF BUOYANCY =  100.37494 FEET   AFT OF F.P.
   LONGITUDINAL CENTER OF BUOYANCY =   11.26922 STATIONS
  LONGITUDINAL CENTER OF FLOTATION =   99.66327 FEET   AFT OF F.P.
  LONGITUDINAL CENTER OF FLOTATION =   11.18932 STATIONS
       VERTICAL CENTER OF BUOYANCY =   15.46576 FEET   FROM THE DESIGNED LOAD WATERLINE
         RADIUS OF GYRATION/L.B.P. =     .31500
                       BEAM/DRAFT =     .27177
                      LENGTH/BEAM =   24.60497

   THE HEAVE-HEAVE RESTORING COEFFICIENT IS     4.12036
   THE HEAVE-PITCH RESTORING COEFFICIENT IS     -.01646
   THE PITCH-PITCH RESTORING COEFFICIENT IS      .12559

   PROJECTED AREA OF THE SUBMERGED HULL/L**2 =     .103721E+00
  MOMENT/L**3 =     .101487E-02     MOMENT OF INERTIA/L**4 =     .135252E-01
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HULL SEPARATION/BEAM = 9.3591

DYNAMIC COEFFICIENTS OF THE EQUATIONS OF MOTION

A33 IS SCALED BY M.

A35 AND A53 ARE SCALED BY M*L.

A55 IS SCALED BY M*L*L.

B33 IS SCALED BY M*SQRT(G/L).

B35 AND B53 ARE SCALED BY M*SQRT(G*L).

B55 IS SCALED BY M*L*SQRT(G*L).

M IS THE DISPLACED MASS.

G IS THE ACCELERATION DUE TO GRAVITY.

L IS THE DISTANCE BETWEEN PERPENDICULARS.

FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT(G*L).

BETA IS THE WAVE HEADING ANGLE IN DEGREES.
BETA = 180. FOR HEAD SEAS.

OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED BYSQRT(G/L).

THE HULL SEPARATION/BEAM RATIO IS THE DISTANCE
BETWEEN THE HULLS DIVIDED BY THE BEAM OF ONE HULL.

HULL SEPARATION/BEAM = 9.3591

BARE HULL POTENTIAL FLOW ADDED MASS AND DAMPING COEFFICIENTS
FN = 0.000

OMEGA	A33	A35	A53	A55	B33	B35	B53	B55
.9000	.641858	.002292	.002292	.090303	.209462	-.000695	-.000695	.011136
1.0000	.621823	.002338	.002338	.089485	.209609	-.000671	-.000671	.011321
1.2000	.594725	.002371	.002371	.088455	.199752	-.000606	-.000606	.011546
1.3000	.585825	.002369	.002369	.088092	.191391	-.000578	-.000578	.011698
1.4000	.578481	.002361	.002361	.087722	.181624	-.000560	-.000560	.011911
1.5000	.571012	.002356	.002356	.087251	.170116	-.000557	-.000557	.012133
1.6000	.561280	.002362	.002362	.086586	.152878	-.000575	-.000575	.012138
1.7000	.551175	.002410	.002410	.085822	.114994	-.000603	-.000603	.011248
1.8000	.562021	.002502	.002502	.085808	.053530	-.000465	-.000465	.009319
1.9000	.589159	.002466	.002466	.086352	.029044	-.000191	-.000191	.008499
2.0000	.604694	.002367	.002367	.086523	.029133	-.000049	-.000049	.008188
2.2000	.619083	.002203	.002203	.086682	.024717	.000008	.000008	.006298
2.4000	.631165	.002067	.002067	.087676	.013167	-.000072	-.000072	.003272
2.7000	.652075	.001930	.001930	.091054	.007888	-.000545	-.000545	.001605
3.0000	.669920	.001979	.001979	.094503	.041337	-.001286	-.001286	.010383
3.5000	.668213	.002223	.002223	.091980	.154891	-.001505	-.001505	.041815

BARE HULL POTENTIAL FLOW ADDED MASS AND DAMPING COEFFICIENTS
FN = .446

OMEGA	A33	A35	A53	A55	B33	B35	B53	B55
.9000	.641858	-.113042	.117625	.247927	.209462	.285574	-.286963	.062575
1.0000	.621823	-.091148	.095824	.213175	.209609	.276662	-.278004	.053015
1.2000	.594725	-.059497	.064239	.170608	.199752	.264641	-.265854	.039139
1.3000	.585825	-.048141	.052878	.157045	.191391	.260700	-.261856	.034225
1.4000	.578481	-.038967	.043690	.146431	.181624	.257442	-.258563	.030343
1.5000	.571012	-.031365	.036077	.137733	.170116	.254114	-.255228	.027173
1.6000	.561280	-.024272	.028997	.130198	.152878	.249756	-.250906	.024017
1.7000	.551175	-.015336	.020157	.123758	.114994	.245221	-.246427	.019163
1.8000	.562021	-.004866	.009871	.120312	.053530	.250196	-.251127	.012606
1.9000	.589159	-.001122	.006055	.118815	.029044	.262574	-.262955	.010100
2.0000	.604694	-.000882	.005615	.116594	.029133	.269645	-.269743	.009636
2.2000	.619083	-.000075	.004481	.112125	.024717	.276120	-.276103	.007313
2.4000	.631165	.001048	.003087	.109473	.013167	.281427	-.281572	.003727
2.7000	.652075	.001447	.002412	.108847	.007888	.290281	-.291370	.001820
3.0000	.669920	-.000070	.004027	.109309	.041337	.297498	-.300070	.011297
3.5000	.668213	-.003417	.007862	.102830	.154891	.296518	-.299528	.044330

HULL SEPARATION/BEAM = 9.3591

ADDED MASS COEFFICIENTS AND DAMPING COEFFICIENTS EXCLUDING CROSS-FLOW DRAG
FN = 0.000

OMEGA	A33	A35	A53	A55	B33	B35	B53	B55
.9000	.730421	.033989	.033989	.109928	.209462	-.000695	-.000695	.011136
1.0000	.710386	.034035	.034035	.109110	.209609	-.000671	-.000671	.011321
1.2000	.683288	.034068	.034068	.108080	.199752	-.000606	-.000606	.011546
1.3000	.674387	.034066	.034066	.107717	.191391	-.000578	-.000578	.011698
1.4000	.667044	.034059	.034059	.107347	.181624	-.000560	-.000560	.011911
1.5000	.659574	.034053	.034053	.106877	.170116	-.000557	-.000557	.012133
1.6000	.649842	.034059	.034059	.106211	.152878	-.000575	-.000575	.012138
1.7000	.639737	.034108	.034108	.105447	.114994	-.000603	-.000603	.011248
1.8000	.650583	.034200	.034200	.105433	.053530	-.000465	-.000465	.009319
1.9000	.677721	.034164	.034164	.105977	.029044	-.000191	-.000191	.008499
2.0000	.693257	.034064	.034064	.106148	.029133	-.000049	-.000049	.008188
2.2000	.707646	.033900	.033900	.106307	.024717	.000008	.000008	.006298
2.4000	.719728	.033764	.033764	.107302	.013167	-.000072	-.000072	.003272
2.7000	.740638	.033627	.033627	.110679	.007888	-.000545	-.000545	.001605
3.0000	.758483	.033676	.033676	.114128	.041337	-.001286	-.001286	.010383
3.5000	.756775	.033920	.033920	.111605	.154891	-.001505	-.001505	.041815

ADDED MASS COEFFICIENTS AND DAMPING COEFFICIENTS EXCLUDING CROSS-FLOW DRAG
FN = .446

OMEGA	A33	A35	A53	A55	B33	B35	B53	B55
.9000	.730421	-.081345	.149322	.289301	1.494499	.592448	-.059087	.309989
1.0000	.710386	-.059451	.127521	.250417	1.494646	.583536	-.050128	.300429
1.2000	.683288	-.027800	.095936	.202466	1.484788	.571515	-.037978	.286553
1.3000	.674387	-.016443	.084575	.187094	1.476428	.567574	-.033980	.281640
1.4000	.667044	-.007270	.075387	.175044	1.466661	.564316	-.030687	.277758
1.5000	.659574	.000333	.067774	.165188	1.455152	.560988	-.027352	.274587
1.6000	.649842	.007425	.060694	.156705	1.437915	.556630	-.023030	.271431
1.7000	.639737	.016361	.051854	.149479	1.400031	.552094	-.018551	.266577
1.8000	.650583	.026831	.041568	.145375	1.338566	.557070	-.023251	.260020
1.9000	.677721	.030575	.037752	.143320	1.314080	.569448	-.035079	.257514
2.0000	.693257	.030816	.037312	.140623	1.314170	.576518	-.041867	.257051
2.2000	.707646	.031623	.036178	.135390	1.309753	.582993	-.048227	.254728
2.4000	.719728	.032745	.034784	.132157	1.298203	.588301	-.053696	.251141
2.7000	.740638	.033144	.034109	.130888	1.292924	.597155	-.063494	.249235
3.0000	.758483	.031627	.035724	.130892	1.326373	.604372	-.072194	.258711
3.5000	.756775	.028281	.039559	.123893	1.439928	.603392	-.071652	.291744

HULL SEPARATION/BEAM = 9.3591

EQUATIONS OF MOTION SOLVED USING DAMPING COEFFICIENTS EXCLUDING CROSS-FLOW DRAG.

FN = 0.000
BETA = 135.0

OMEGA	HEAVE	PHASE	PITCH	PHASE	LAM/L
.900	1.03857	.691	.75892	131.285	7.7570
1.000	1.07577	-.060	.41733	136.007	6.2832
1.200	1.22950	-2.646	.22450	167.254	4.3633
1.300	1.41397	-5.810	.22385	-175.964	3.7179
1.400	1.81668	-12.705	.26163	-170.256	3.2057
1.500	2.97479	-32.069	.35086	170.577	2.7925
1.600	4.76868	-115.859	.46620	55.933	2.4544
1.700	1.52849	-188.349	.34051	-48.345	2.1741
1.800	.41728	-230.219	.33589	-80.930	1.9393
1.900	.05970	-236.475	.30832	-92.929	1.7405
2.000	.04364	-146.531	.27946	-96.154	1.5708
2.200	.06133	-159.992	.22173	-95.770	1.2982
2.400	.06373	-172.889	.15236	-92.362	1.0908
2.700	.05209	-173.193	.05349	-77.253	.8619
3.000	.02685	-153.794	.01114	4.129	.6981
3.500	.00911	-111.917	.02121	-120.922	.5129

FN = 0.000
BETA = 180.0

OMEGA	HEAVE	PHASE	PITCH	PHASE	LAM/L
.900	1.03245	1.000	1.02035	125.058	7.7570
1.000	1.06805	.027	.54076	128.613	6.2832
1.200	1.21305	-2.551	.25094	162.677	4.3633
1.300	1.39074	-5.258	.24517	-174.679	3.7179
1.400	1.78620	-10.880	.29450	-164.326	3.2057
1.500	2.95086	-27.130	.39654	-177.868	2.7925
1.600	4.92107	-103.657	.41216	77.874	2.4544
1.700	1.84322	-160.333	.24377	-42.347	2.1741
1.800	.87373	-177.368	.26403	-74.023	1.9393
1.900	.52006	-182.338	.25833	-83.464	1.7405
2.000	.37737	-183.771	.23537	-86.487	1.5708
2.200	.26407	-184.626	.15082	-86.336	1.2982
2.400	.20755	-183.355	.03664	-68.876	1.0908
2.700	.12059	-179.563	.12672	81.793	.8619
3.000	.02078	-151.903	.16669	83.288	.6981
3.500	.04587	-15.075	.01517	-148.010	.5129

HULL SEPARATION/BEAM = 9.3591

EQUATIONS OF MOTION SOLVED USING DAMPING COEFFICIENTS EXCLUDING CROSS-FLOW DRAG.

FN = .446

BETA = 135.0

OMEGA	HEAVE	PHASE	PITCH	PHASE	LAM/L
.900	1.22637	-15.858	.42593	-171.785	11.7478
1.000	1.27278	-20.482	.43645	-175.821	9.8475
1.200	1.37092	-34.019	.44333	174.711	7.2919
1.300	1.40495	-43.798	.43908	168.612	6.4035
1.400	1.40087	-56.094	.42482	161.002	5.6840
1.500	1.32794	-70.723	.39316	151.916	5.0918
1.600	1.17238	-86.692	.34065	142.508	4.5977
1.700	.95145	-102.752	.27686	135.066	4.1803
1.800	.69677	-116.175	.22296	130.076	3.8240
1.900	.49668	-123.505	.17470	123.780	3.5171
2.000	.36241	-128.765	.12710	118.009	3.2503
2.200	.18651	-137.608	.05157	107.094	2.8110
2.400	.08360	-145.232	.00929	3.163	2.4656
2.700	.00611	-198.386	.06016	-60.433	2.0694
3.000	.02794	36.900	.09476	-66.778	1.7731
3.500	.03531	33.296	.11594	-73.270	1.4194

FN = .446

BETA = 180.0

OMEGA	HEAVE	PHASE	PITCH	PHASE	LAM/L
.900	1.25478	-15.644	.44915	-170.243	13.2528
1.000	1.31062	-20.287	.46351	-174.465	11.1857
1.200	1.43291	-33.850	.47725	175.445	8.3833
1.300	1.48104	-43.577	.47571	168.921	7.4013
1.400	1.49086	-55.689	.46335	160.902	6.6021
1.500	1.42997	-69.849	.43226	151.021	5.9415
1.600	1.28716	-84.782	.37756	140.381	5.3879
1.700	1.09510	-99.210	.30375	130.619	4.9185
1.800	.88012	-113.192	.22918	125.028	4.5163
1.900	.66251	-124.402	.17562	122.216	4.1684
2.000	.49213	-132.140	.13136	118.761	3.8652
2.200	.27271	-142.734	.05824	110.762	3.3633
2.400	.14797	-150.326	.00702	38.563	2.9665
2.700	.05179	-159.194	.06038	-64.164	2.5082
3.000	.01310	-167.410	.09856	-72.355	2.1629
3.500	.00484	-216.872	.11429	-80.758	1.7474

HULL SEPARATION/BEAM = 9.3591

EQUATIONS OF MOTION SOLVED USING EXCITING FORCE INCLUDING FIN AND BODY LIFT CONTRIBUTIONS.

FN = 0.000
BETA = 135.0

OMEGA	HEAVE	PHASE	PITCH	PHASE	LAM/L
.900	1.03857	.691	.75892	131.285	7.7570
1.000	1.07577	-.060	.41733	136.007	6.2832
1.200	1.22950	-2.646	.22450	167.254	4.3633
1.300	1.41397	-5.810	.22385	-175.964	3.7179
1.400	1.81668	-12.705	.26163	-170.256	3.2057
1.500	2.97479	-32.069	.35066	170.577	2.7925
1.600	4.76868	-115.859	.46620	55.933	2.4544
1.700	1.52849	-188.349	.34051	-48.345	2.1741
1.800	.41728	-230.219	.33589	-80.930	1.9393
1.900	.05970	-236.475	.30832	-92.929	1.7405
2.000	.04364	-146.531	.27946	-96.154	1.5708
2.200	.06133	-159.992	.22173	-95.770	1.2982
2.400	.06373	-172.889	.15236	-92.362	1.0908
2.700	.05209	-173.193	.05349	-77.253	.8619
3.000	.02685	-153.794	.01114	4.129	.6981
3.500	.00911	-111.917	.02121	-120.922	.5129

FN = 0.000
BETA = 180.0

OMEGA	HEAVE	PHASE	PITCH	PHASE	LAM/L
.900	1.03245	1.000	1.02035	125.058	7.7570
1.000	1.06805	.027	.54076	128.613	6.2832
1.200	1.21305	-2.551	.25094	162.677	4.3633
1.300	1.39074	-5.258	.24517	-174.679	3.7179
1.400	1.78620	-10.880	.29450	-164.326	3.2057
1.500	2.95086	-27.130	.39654	-177.868	2.7925
1.600	4.92107	-103.657	.41216	77.874	2.4544
1.700	1.84322	-160.333	.24377	-42.347	2.1741
1.800	.87373	-177.368	.26403	-74.023	1.9393
1.900	.52006	-182.338	.25833	-83.464	1.7405
2.000	.37737	-183.771	.23537	-86.487	1.5708
2.200	.26407	-184.626	.15082	-86.336	1.2982
2.400	.20755	-183.355	.03664	-68.876	1.0908
2.700	.12059	-179.563	.12672	81.793	.8619
3.000	.02078	-151.903	.16669	83.288	.6981
3.500	.04587	-15.075	.01517	-148.010	.5129

HULL SEPARATION/BEAM = 9.3591

EQUATIONS OF MOTION SOLVED USING EXCITING FORCE INCLUDING FIN AND BODY LIFT CONTRIBUTIONS.

FN = .446
BETA = 135.0

OMEGA	HEAVE	PHASE	PITCH	PHASE	LAM/L
.900	1.12507	-2.495	.23387	-108.273	11.7478
1.000	1.17812	-4.516	.27179	-113.190	9.8475
1.200	1.31682	-12.479	.33977	-124.142	7.2919
1.300	1.38786	-19.383	.36473	-130.611	6.4035
1.400	1.43108	-28.769	.37683	-137.835	5.6840
1.500	1.40887	-40.396	.36943	-145.173	5.0918
1.600	1.29500	-53.013	.34222	-151.025	4.5977
1.700	1.10237	-64.546	.30726	-153.845	4.1803
1.800	.89072	-72.213	.27561	-154.359	3.8240
1.900	.73054	-76.752	.24625	-152.419	3.5171
2.000	.60166	-80.480	.22722	-148.249	3.2503
2.200	.40540	-84.600	.21210	-140.042	2.8110
2.400	.27591	-85.203	.20580	-134.347	2.4656
2.700	.15809	-81.997	.19516	-128.255	2.0694
3.000	.09219	-75.845	.18326	-123.358	1.7731
3.500	.03434	-63.630	.16159	-119.288	1.4194

FN = .446
BETA = 180.0

OMEGA	HEAVE	PHASE	PITCH	PHASE	LAM/L
.900	1.16117	-2.800	.28131	-115.147	13.2528
1.000	1.22497	-5.100	.32292	-120.087	11.1857
1.200	1.38944	-13.814	.39458	-131.221	8.3833
1.300	1.47478	-21.129	.41945	-137.839	7.4013
1.400	1.53226	-30.875	.42963	-145.324	6.6021
1.500	1.52405	-42.734	.41716	-153.165	5.9415
1.600	1.42820	-55.442	.37935	-159.814	5.3879
1.700	1.26752	-67.653	.32648	-162.704	4.9185
1.800	1.06631	-79.066	.28636	-160.068	4.5163
1.900	.85161	-87.494	.26755	-156.938	4.1684
2.000	.67834	-92.656	.25200	-154.164	3.8652
2.200	.44354	-98.247	.23113	-147.943	3.3633
2.400	.29875	-100.601	.21883	-142.394	2.9665
2.700	.17146	-101.389	.20551	-135.535	2.5082
3.000	.10190	-102.656	.19541	-130.785	2.1629
3.500	.04393	-123.001	.17042	-130.023	1.7474

HULL SEPARATION/BEAM = 9.3591

EQUATIONS OF MOTION SOLVED WITH VISCOUS CROSS-FLOW DAMPING EFFECTS.
FN = 0.000
BETA = 135.0

OMEGA	HEAVE	PHASE	PITCH	PHASE	LAM/L
.900	1.03857	.691	.75892	131.285	7.7570
1.000	1.07577	-.060	.41733	136.007	6.2832
1.200	1.22950	-2.646	.22450	167.254	4.3633
1.300	1.41397	-5.810	.22385	-175.964	3.7179
1.400	1.81668	-12.705	.26163	-170.256	3.2057
1.500	2.97479	-32.069	.35086	170.577	2.7925
1.600	4.76868	-115.859	.46620	55.933	2.4544
1.700	1.52849	-188.349	.34051	-48.345	2.1741
1.800	.41728	-230.219	.33589	-80.930	1.9393
1.900	.05970	-236.475	.30832	-92.929	1.7405
2.000	.04364	-146.531	.27946	-96.154	1.5708
2.200	.06133	-159.992	.22173	-95.770	1.2982
2.400	.06373	-172.889	.15236	-92.362	1.0908
2.700	.05209	-173.193	.05349	-77.253	.8619
3.000	.02685	-153.794	.01114	4.129	.6981
3.500	.00911	-111.917	.02121	-120.922	.5129

176

HULL SEPARATION/BEAM = 9.3591

EQUATIONS OF MOTION SOLVED WITH VISCOUS CROSS-FLOW DAMPING EFFECTS.
FN = 0.000
BETA = 135.0

OMEGA	HEAVE	PHASE	PITCH	PHASE	LAM/L
.900	1.03806	.630	.75825	134.250	7.7570
1.000	1.07542	-.113	.42078	137.714	6.2832
1.200	1.22812	-2.827	.22964	168.256	4.3633
1.300	1.40950	-6.267	.23002	-175.441	3.7179
1.400	1.79301	-14.176	.26706	-170.301	3.2057
1.500	2.66422	-38.292	.31678	169.582	2.7925
1.600	2.58305	-102.410	.14724	77.361	2.4544
1.700	1.40742	-177.303	.29847	-47.680	2.1741
1.800	.40240	-226.330	.33302	-81.348	1.9393
1.900	.05385	-230.838	.30795	-93.313	1.7405
2.000	.04632	-140.849	.27945	-96.575	1.5708
2.200	.06203	-157.630	.22165	-96.241	1.2982
2.400	.06382	-171.850	.15199	-92.905	1.0908
2.700	.05201	-173.101	.05275	-77.936	.8619
3.000	.02657	-154.090	.01098	6.510	.6981
3.500	.00897	-111.055	.02107	-120.383	.5129

1

MOT35 HEAVE AND PITCH MOTIONS OF SWATH 6A PAGE 15

HULL SEPARATION/BEAM = 9.3591

EQUATIONS OF MOTION SOLVED WITH VISCOUS CROSS-FLOW DAMPING EFFECTS.
FN = 0.000
BETA = 180.0

OMEGA	HEAVE	PHASE	PITCH	PHASE	LAM/L
.900	1.03245	1.000	1.02035	125.058	7.7570
1.000	1.06805	.027	.54076	128.613	6.2832
1.200	1.21305	-2.551	.25094	162.677	4.3633
1.300	1.39074	-5.258	.24517	-174.679	3.7179
1.400	1.78620	-10.880	.29450	-164.326	3.2057
1.500	2.95086	-27.130	.39654	-177.868	2.7925
1.600	4.92107	-103.657	.41216	77.874	2.4544
1.700	1.84322	-160.333	.24377	-42.347	2.1741
1.800	.87373	-177.368	.26403	-74.023	1.9393
1.900	.52006	-182.338	.25833	-83.464	1.7405
2.000	.37737	-183.771	.23537	-86.487	1.5708
2.200	.26407	-184.626	.15082	-86.336	1.2982
2.400	.20755	-183.355	.03664	-68.876	1.0908
2.700	.12059	-179.563	.12672	81.793	.8619
3.000	.02078	-151.903	.16669	83.288	.6981
3.500	.04587	-15.075	.01517	-148.010	.5129

177

MOT35 HEAVE AND PITCH MOTIONS OF SWATH 6A PAGE 16

HULL SEPARATION/BEAM = 9.3591

EQUATIONS OF MOTION SOLVED WITH VISCOUS CROSS-FLOW DAMPING EFFECTS.
FN = 0.000
BETA = 180.0

OMEGA	HEAVE	PHASE	PITCH	PHASE	LAM/L
.900	1.03155	.902	1.01693	129.229	7.7570
1.000	1.06757	-.048	.54610	131.057	6.2832
1.200	1.21137	-2.779	.25939	164.064	4.3633
1.300	1.38570	-5.800	.25483	-174.220	3.7179
1.400	1.76164	-12.528	.30348	-164.629	3.2057
1.500	2.64237	-33.801	.36806	-178.320	2.7925
1.600	2.69834	-91.435	.15571	131.026	2.4544
1.700	1.72340	-149.354	.18506	-45.561	2.1741
1.800	.86720	-172.995	.25430	-75.570	1.9393
1.900	.51874	-179.965	.25549	-84.448	1.7405
2.000	.37665	-182.160	.23389	-87.282	1.5708
2.200	.26374	-183.760	.14989	-87.174	1.2982
2.400	.20733	-182.914	.03547	-70.833	1.0908
2.700	.12032	-179.475	.12695	82.145	.8619
3.000	.02050	-152.173	.16664	83.354	.6981
3.500	.04588	-15.012	.01517	-146.838	.5129

1

MOT35 HEAVE AND PITCH MOTIONS OF SWATH 6A PAGE 17

HULL SEPARATION/BEAM = 9.3591

EQUATIONS OF MOTION SOLVED WITH VISCOUS CROSS-FLOW DAMPING EFFECTS.
FN = .446
BETA = 135.0

OMEGA	HEAVE	PHASE	PITCH	PHASE	LAM/L
.900	1.12507	-2.495	.23387	-108.273	11.7478
1.000	1.17812	-4.516	.27179	-113.190	9.8475
1.200	1.31682	-12.479	.33977	-124.142	7.2919
1.300	1.38786	-19.383	.36473	-130.611	6.4035
1.400	1.43108	-28.769	.37683	-137.835	5.6840
1.500	1.40887	-40.396	.36943	-145.173	5.0918
1.600	1.29500	-53.013	.34222	-151.025	4.5977
1.700	1.10237	-64.546	.30726	-153.845	4.1803
1.800	.89072	-72.213	.27561	-154.359	3.8240
1.900	.73054	-76.752	.24625	-152.419	3.5171
2.000	.60166	-80.480	.22722	-148.249	3.2503
2.200	.40540	-84.600	.21210	-140.042	2.8110
2.400	.27591	-85.203	.20580	-134.347	2.4656
2.700	.15809	-81.997	.19516	-128.255	2.0694
3.000	.09219	-75.845	.18326	-123.358	1.7731
3.500	.03434	-63.630	.16159	-119.288	1.4194

MOT35 HEAVE AND PITCH MOTIONS OF SWATH 6A PAGE 18

HULL SEPARATION/BEAM = 9.3591

EQUATIONS OF MOTION SOLVED WITH VISCOUS CROSS-FLOW DAMPING EFFECTS.
FN = .446
BETA = 135.0

OMEGA	HEAVE	PHASE	PITCH	PHASE	LAM/L
.900	1.12478	-2.528	.23364	-108.296	11.7478
1.000	1.17734	-4.575	.27136	-113.206	9.8475
1.200	1.31255	-12.615	.33841	-124.113	7.2919
1.300	1.37904	-19.540	.36240	-130.504	6.4035
1.400	1.41528	-28.861	.37328	-137.544	5.6840
1.500	1.38632	-40.255	.36525	-144.542	5.0918
1.600	1.27113	-52.488	.33912	-150.002	4.5977
1.700	1.08398	-63.638	.30644	-152.653	4.1803
1.800	.88073	-71.069	.27640	-153.299	3.8240
1.900	.72660	-75.581	.24783	-151.514	3.5171
2.000	.60085	-79.369	.22923	-147.525	3.2503
2.200	.40690	-83.651	.21413	-139.651	2.8110
2.400	.27780	-84.405	.20755	-134.150	2.4656
2.700	.15970	-81.389	.19649	-128.208	2.0694
3.000	.09337	-75.413	.18427	-123.385	1.7731
3.500	.03494	-63.503	.16225	-119.349	1.4194

1

MOT35 HEAVE AND PITCH MOTIONS OF SWATH 6A PAGE 19

HULL SEPARATION/BEAM = 9.3591

EQUATIONS OF MOTION SOLVED WITH VISCOUS CROSS-FLOW DAMPING EFFECTS.
FN = .446
BETA = 180.0

OMEGA	HEAVE	PHASE	PITCH	PHASE	LAM/L
.900	1.16117	-2.800	.28131	-115.147	13.2528
1.000	1.22497	-5.100	.32292	-120.087	11.1857
1.200	1.38944	-13.814	.39458	-131.221	8.3833
1.300	1.47478	-21.129	.41945	-137.839	7.4013
1.400	1.53226	-30.875	.42963	-145.324	6.6021
1.500	1.52405	-42.734	.41716	-153.165	5.9415
1.600	1.42820	-55.442	.37935	-159.814	5.3879
1.700	1.26752	-67.653	.32648	-162.704	4.9185
1.800	1.06631	-79.066	.28636	-160.066	4.5163
1.900	.85161	-87.494	.26755	-156.938	4.1684
2.000	.67834	-92.656	.25200	-154.164	3.8652
2.200	.44354	-98.247	.23113	-147.943	3.3633
2.400	.29875	-100.601	.21883	-142.394	2.9665
2.700	.17146	-101.389	.20551	-135.535	2.5082
3.000	.10190	-102.656	.19541	-130.785	2.1629
3.500	.04393	-123.001	.17042	-130.023	1.7474

MOT35 HEAVE AND PITCH MOTIONS OF SWATH 6A PAGE 20

HULL SEPARATION/BEAM = 9.3591

EQUATIONS OF MOTION SOLVED WITH VISCOUS CROSS-FLOW DAMPING EFFECTS.
FN = .446
BETA = 180.0

OMEGA	HEAVE	PHASE	PITCH	PHASE	LAM/L
.900	1.16067	-2.847	.28099	-115.143	13.2528
1.000	1.22374	-5.179	.32236	-120.067	11.1857
1.200	1.38338	-13.986	.39288	-131.129	8.3833
1.300	1.46272	-21.324	.41658	-137.651	7.4013
1.400	1.51122	-30.992	.42530	-144.927	6.6021
1.500	1.49437	-42.584	.41207	-152.389	5.9415
1.600	1.39638	-54.865	.37553	-158.573	5.3879
1.700	1.24100	-66.653	.32558	-161.170	4.9185
1.800	1.04885	-77.771	.28774	-158.645	4.5163
1.900	.84293	-86.125	.26980	-155.783	4.1684
2.000	.67483	-91.346	.25467	-153.262	3.8652
2.200	.44398	-97.123	.23378	-147.450	3.3633
2.400	.30008	-99.640	.22109	-142.156	2.9665
2.700	.17273	-100.601	.20716	-135.502	2.5082
3.000	.10280	-101.945	.19661	-130.828	2.1629
3.500	.04424	-122.087	.17127	-130.074	1.7474

HULL SEPARATION/BEAM = 9.3591

DAMPING COEFFICIENTS INCLUDING CROSS-FLOW DRAG
FN = 0.000

	BETA = 135.0				BETA = 180.0			
OMEGA	B33	B35	B53	B55	B33	B35	B53	B55
.9000	.219953	.000148	.000148	.013223	.223772	.000620	.000620	.014023
1.0000	.218291	-.000271	-.000271	.012960	.221052	.000082	.000082	.013565
1.2000	.211142	-.000737	-.000737	.013413	.213131	-.000480	-.000480	.013931
1.3000	.207792	-.000872	-.000872	.014249	.209512	-.000696	-.000696	.014747
1.4000	.209499	-.000893	-.000893	.016098	.210938	-.000842	-.000842	.016572
1.5000	.232017	-.000596	-.000596	.021183	.232919	-.000845	-.000845	.021576
1.6000	.288089	.001313	.001313	.031383	.288048	-.000099	-.000099	.031251
1.7000	.174240	.001623	.001623	.019447	.178552	.000298	.000298	.019605
1.8000	.079732	.001754	.001754	.012777	.090614	.000564	.000564	.013746
1.9000	.047655	.001033	.001033	.010889	.055530	.000724	.000724	.011315
2.0000	.047757	.000773	.000773	.010565	.051406	.000815	.000815	.010420
2.2000	.044195	.000855	.000855	.008841	.044994	.000921	.000921	.008476
2.4000	.033421	.000980	.000980	.006027	.033621	.000990	.000990	.005670
2.7000	.028558	.000761	.000761	.004565	.027510	.000477	.000477	.003958
3.0000	.060953	.000042	.000042	.013262	.058920	-.000480	-.000480	.012567
3.5000	.171088	-.000323	-.000323	.044209	.170775	-.000478	-.000478	.044070

DAMPING COEFFICIENTS INCLUDING CROSS-FLOW DRAG
FN = .446

	BETA = 135.0				BETA = 180.0			
OMEGA	B33	B35	B53	B55	B33	B35	B53	B55
.9000	1.500268	.592600	-.058935	.310840	1.501327	.592480	-.059055	.310989
1.0000	1.502428	.583687	-.049977	.301575	1.503780	.583522	-.050142	.301764
1.2000	1.498457	.571702	-.037790	.288561	1.500607	.571434	-.038058	.288861
1.3000	1.494107	.567829	-.033724	.284236	1.496756	.567504	-.034050	.284606
1.4000	1.488788	.564691	-.030312	.281007	1.491952	.564304	-.030699	.281448
1.5000	1.481363	.561529	-.026811	.278435	1.484985	.561079	-.027262	.278936
1.6000	1.466729	.557362	-.022298	.275659	1.470784	.556853	-.022807	.276214
1.7000	1.429244	.552991	-.017655	.270860	1.434153	.552496	-.018149	.271528
1.8000	1.366257	.557983	-.022337	.264069	1.372332	.557767	-.022553	.264907
1.9000	1.340219	.570286	-.034241	.261314	1.345773	.570327	-.034200	.262087
2.0000	1.339042	.577340	-.041045	.260641	1.343517	.577421	-.040964	.261260
2.2000	1.332272	.583804	-.047417	.257925	1.335332	.583837	-.047383	.258332
2.4000	1.318878	.589061	-.052937	.254017	1.321065	.589033	-.052964	.254287
2.7000	1.311821	.597814	-.062835	.251782	1.313013	.597660	-.062988	.251879
3.0000	1.344501	.605017	-.071549	.261121	1.344838	.604654	-.071913	.261034
3.5000	1.458160	.604178	-.070866	.294195	1.457901	.603565	-.071479	.293971

HULL SEPARATION/BEAM = 9.3591

EXCITING FORCE, MOMENT AND PHASES

THE FORCE AMPLITUDE IS SCALED BY THE HEAVE RESTORING FORCE
C33 = RHO*G*A*(WATERPLANE AREA).

THE MOMENT AMPLITUDE IS SCALED BY THE PITCH RESTORING MOMENT
C55 = RHO*G*A*(MOMENT OF INERTIA OF WATERPLANE)/L.

MOMENT DENOTES THE MOMENT AMPLITUDE SCALED BY L(WAVE NUMBER)*C55.

G IS THE ACCELERATION DUE TO GRAVITY.

A IS THE WAVE AMPLITUDE.

L IS THE DISTANCE BETWEEN PERPENDICULARS.

RHO IS THE WATER DENSITY.

FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT(G*L).

BETA IS THE WAVE HEADING ANGLE IN DEGREES.
BETA = 180. FOR HEAD SEAS.

OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED BY SQRT(G/L).

THE PHASE ANGLE IS MEASURED IN DEGREES WITH RESPECT TO THE WAVE AT THE CG.

L/LAM IS L/(WAVE LENGTH).

FOR FOLLOWING SEAS THE FREQUENCY DOMAIN IS DIVIDED INTO THREE
REGIONS SEPARATED BY TWO CRITICAL L/LAM DENOTED CWR1 AND CWR2.

HULL SEPARATION/BEAM = 9.3591

EXCITING FORCE, MOMENT AND PHASES
FN = 0.000
BETA = 135.0

OMEGA	L/LAM	FORCE	PHASE	MOMENT	PHASE	*MOMENT	LAM/L
.9000	.1289	.69712	3.764	.24307	-101.407	.30009	7.7570
1.0000	.1592	.63866	4.386	.22044	-100.414	.22044	6.2832
1.2000	.2292	.51825	5.436	.08237	-101.474	.05720	4.3633
1.3000	.2690	.45934	5.553	.03743	92.610	.02215	3.7179
1.4000	.3119	.40324	4.954	.18801	85.372	.09592	3.2057
1.5000	.3581	.35014	3.172	.36945	83.305	.16420	2.7925
1.6000	.4074	.29442	-1.185	.59107	81.343	.23089	2.4544
1.7000	.4600	.21940	-20.975	.87706	92.766	.30348	2.1741
1.8000	.5157	.10334	-47.324	1.25243	90.768	.38655	1.9393
1.9000	.5745	.01657	1.652	1.47023	83.965	.40727	1.7405
2.0000	.6366	.04671	55.612	1.55136	80.983	.38784	1.5708
2.2000	.7703	.07352	34.533	1.53837	81.045	.31784	1.2982
2.4000	.9167	.09382	16.731	1.28394	83.997	.22291	1.0908
2.7000	1.1602	.10777	9.932	.58072	96.293	.07966	.8619
3.0000	1.4324	.07388	25.435	.12434	179.805	.01382	.6981
3.5000	1.9496	.04230	66.223	.42305	56.481	.03453	.5129

EXCITING FORCE, MOMENT AND PHASES
FN = 0.000
BETA = 180.0

OMEGA	L/LAM	FORCE	PHASE	MOMENT	PHASE	*MOMENT	LAM/L
.9000	.1289	.69468	3.643	.33787	-95.948	.41712	7.7570
1.0000	.1592	.63495	4.212	.30670	-94.209	.30670	6.2832
1.2000	.2292	.51208	5.460	.11869	-81.278	.08243	4.3633
1.3000	.2690	.45277	6.124	.06512	41.201	.03853	3.7179
1.4000	.3119	.39801	6.864	.25783	68.864	.13154	3.2057
1.5000	.3581	.35058	8.047	.49271	69.794	.21898	2.7925
1.6000	.4074	.31328	9.949	.75289	66.384	.29410	2.4544
1.7000	.4600	.28168	6.123	.94212	75.718	.32599	2.1741
1.8000	.5157	.25713	2.827	1.12350	79.158	.34676	1.9393
1.9000	.5745	.24230	.978	1.25001	80.390	.34626	1.7405
2.0000	.6366	.24133	-.266	1.28639	80.892	.32160	1.5708
2.2000	.7703	.26402	-2.300	1.02287	81.102	.21134	1.2982
2.4000	.9167	.28978	-3.048	.28204	73.982	.04897	1.0908
2.7000	1.1602	.24847	-3.654	1.39015	-93.236	.19069	.8619
3.0000	1.4324	.04904	.841	2.33866	-97.338	.25985	.6981
3.5000	1.9496	.19185	-197.711	.24428	42.465	.01994	.5129

HULL SEPARATION/BEAM = 9.3591

EXCITING FORCE, MOMENT AND PHASES
FN = .446
BETA = 135.0

OMEGA	L/LAM	FORCE	PHASE	MOMENT	PHASE	*MOMENT	LAM/L
.9000	.0851	.83128	17.464	.26278	-109.846	.49133	11.7478
1.0000	.1015	.80530	19.448	.22565	-90.824	.35366	9.8475
1.2000	.1371	.75177	23.238	.26508	-35.330	.30764	7.2919
1.3000	.1562	.72414	24.967	.36366	-16.126	.37062	6.4035
1.4000	.1759	.69548	26.478	.50091	-4.319	.45315	5.6840
1.5000	.1964	.66425	27.602	.67175	2.901	.54438	5.0918
1.6000	.2175	.62543	28.116	.87772	6.622	.64227	4.5977
1.7000	.2392	.56627	28.547	1.10169	6.120	.73297	4.1803
1.8000	.2615	.49626	32.966	1.22845	2.887	.74765	3.8240
1.9000	.2843	.47384	39.645	1.25906	5.115	.70477	3.5171
2.0000	.3077	.46606	43.017	1.35208	10.569	.69944	3.2503
2.2000	.3557	.42915	46.231	1.65007	18.710	.73821	2.8110
2.4000	.4056	.37824	48.480	1.96266	24.171	.77018	2.4656
2.7000	.4832	.29738	50.693	2.40885	30.960	.79337	2.0694
3.0000	.5640	.22274	49.784	2.85021	36.273	.80432	1.7731
3.5000	.7045	.12307	26.699	3.41945	39.417	.77247	1.4194

EXCITING FORCE, MOMENT AND PHASES
FN = .446
BETA = 180.0

OMEGA	L/LAM	FORCE	PHASE	MOMENT	PHASE	*MOMENT	LAM/L
.9000	.0755	.84664	16.069	.33458	-92.214	.70572	13.2528
1.0000	.0894	.82308	17.757	.34163	-75.862	.60820	11.1857
1.2000	.1193	.77383	20.997	.43660	-43.619	.58253	8.3833
1.3000	.1351	.74836	22.550	.52506	-31.231	.61850	7.4013
1.4000	.1515	.72261	24.045	.63501	-21.484	.66724	6.6021
1.5000	.1683	.69686	25.436	.76235	-13.728	.72089	5.9415
1.6000	.1856	.67124	26.605	.90599	-7.358	.77690	5.3879
1.7000	.2033	.64392	27.323	1.07151	-2.221	.83878	4.9185
1.8000	.2214	.60867	27.823	1.25230	.919	.90013	4.5163
1.9000	.2399	.57171	28.998	1.40768	3.094	.93389	4.1684
2.0000	.2587	.54024	30.279	1.55041	5.702	.95375	3.8652
2.2000	.2973	.48298	32.064	1.83897	11.128	.98438	3.3633
2.4000	.3371	.42873	32.870	2.12732	16.389	1.00438	2.9665
2.7000	.3987	.35674	31.767	2.58288	23.853	1.03106	2.5082
3.0000	.4623	.30323	25.824	3.09333	28.954	1.06485	2.1629
3.5000	.5723	.26880	.584	3.68293	28.733	1.02422	1.7474

HULL SEPARATION/BEAM = 9.3591

MOTION AMPLITUDES AND PHASES

THE HEAVE AMPLITUDE IS SCALED BY A.

THE PITCH AMPLITUDE IS SCALED BY 2*A/L.

PITCH DENOTES PITCH AMPLITUDE SCALED BY A(WAVE NUMBER).

A IS THE WAVE AMPLITUDE.

FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT(G*L).

BETA IS THE WAVE HEADING ANGLE IN DEGREES.
BETA = 180. FOR HEAD SEAS.

OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED BY SQRT(G/L).

THE PHASE ANGLE IS MEASURED IN DEGREES WITH RESPECT TO THE WAVE AT THE CG.

L/LAM IS L/(WAVE LENGTH).

FOR FOLLOWING SEAS THE FREQUENCY DOMAIN IS DIVIDED INTO THREE
REGIONS SEPARATED BY TWO CRITICAL L/LAM DENOTED CWR1 AND CWR2.

HULL SEPARATION/BEAM = 9.3591

MOTION AMPLITUDES AND PHASES
FN = 0.000
BETA = 135.0

OMEGA	L/LAM	HEAVE	PHASE	PITCH	PHASE	*PITCH	LAM/L
.9000	.1289	1.03806	.630	.75825	134.250	1.87223	7.7570
1.0000	.1592	1.07542	-.113	.42078	137.714	.84157	6.2832
1.2000	.2292	1.22812	-2.827	.22964	168.256	.31895	4.3633
1.3000	.2690	1.40950	-6.267	.23002	-175.441	.27222	3.7179
1.4000	.3119	1.79301	-14.176	.26706	-170.301	.27251	3.2057
1.5000	.3581	2.66422	-38.292	.31678	169.582	.28158	2.7925
1.6000	.4074	2.58305	-102.410	.14724	77.361	.11503	2.4544
1.7000	.4600	1.40742	-177.303	.29847	-47.680	.20655	2.1741
1.8000	.5157	.40240	-226.330	.33302	-81.348	.20557	1.9393
1.9000	.5745	.05385	-230.838	.30795	-93.313	.17061	1.7405
2.0000	.6366	.04632	-140.849	.27945	-96.575	.13973	1.5708
2.2000	.7703	.06203	-157.630	.22165	-96.241	.09159	1.2982
2.4000	.9167	.06382	-171.850	.15199	-92.905	.05277	1.0908
2.7000	1.1602	.05201	-173.101	.05275	-77.936	.01447	.8619
3.0000	1.4324	.02657	-154.090	.01098	6.510	.00244	.6981
3.5000	1.9496	.00897	-111.055	.02107	-120.383	.00344	.5129

MOTION AMPLITUDES AND PHASES
FN = .446
BETA = 135.0

OMEGA	L/LAM	HEAVE	PHASE	PITCH	PHASE	*PITCH	LAM/L
.9000	.0851	1.12478	-2.528	.23364	-108.296	.87368	11.7478
1.0000	.1015	1.17734	-4.575	.27136	-113.206	.85061	9.8475
1.2000	.1371	1.31255	-12.615	.33841	-124.113	.78547	7.2919
1.3000	.1562	1.37904	-19.540	.36240	-130.504	.73868	6.4035
1.4000	.1759	1.41528	-28.861	.37328	-137.544	.67537	5.6840
1.5000	.1964	1.38632	-40.255	.36525	-144.542	.59200	5.0918
1.6000	.2175	1.27113	-52.488	.33912	-150.002	.49629	4.5977
1.7000	.2392	1.08398	-63.638	.30644	-152.653	.40775	4.1803
1.8000	.2615	.88073	-71.069	.27640	-153.299	.33644	3.8240
1.9000	.2843	.72660	-75.581	.24783	-151.514	.27745	3.5171
2.0000	.3077	.60085	-79.369	.22923	-147.525	.23716	3.2503
2.2000	.3557	.40690	-83.651	.21413	-139.651	.19160	2.8110
2.4000	.4056	.27780	-84.405	.20755	-134.150	.16289	2.4656
2.7000	.4832	.15970	-81.389	.19649	-128.208	.12943	2.0694
3.0000	.5640	.09337	-75.413	.18427	-123.385	.10400	1.7731
3.5000	.7045	.03494	-63.503	.16225	-119.349	.07331	1.4194

HULL SEPARATION/BEAM = 9.3591

MOTION AMPLITUDES AND PHASES
FN = 0.000
BETA = 180.0

OMEGA	L/LAM	HEAVE	PHASE	PITCH	PHASE	*PITCH	LAM/L
.9000	.1289	1.03155	.902	1.01693	129.229	2.51095	7.7570
1.0000	.1592	1.06757	-.048	.54610	131.057	1.09221	6.2832
1.2000	.2292	1.21137	-2.779	.25939	164.064	.36027	4.3633
1.3000	.2690	1.38570	-5.800	.25483	-174.220	.30158	3.7179
1.4000	.3119	1.76164	-12.528	.30348	-164.629	.30967	3.2057
1.5000	.3581	2.64237	-33.801	.36806	-178.320	.32716	2.7925
1.6000	.4074	2.69834	-91.435	.15571	131.026	.12165	2.4544
1.7000	.4600	1.72340	-149.354	.18506	-45.561	.12807	2.1741
1.8000	.5157	.86720	-172.995	.25430	-75.570	.15697	1.9393
1.9000	.5745	.51874	-179.965	.25549	-84.448	.14154	1.7405
2.0000	.6366	.37665	-182.160	.23389	-87.282	.11695	1.5708
2.2000	.7703	.26374	-183.760	.14989	-87.174	.06194	1.2982
2.4000	.9167	.20733	-182.914	.03547	-70.833	.01232	1.0908
2.7000	1.1602	.12032	-179.475	.12695	82.145	.03483	.8619
3.0000	1.4324	.02050	-152.173	.16664	83.354	.03703	.6981
3.5000	1.9496	.04588	-15.012	.01517	-146.838	.00248	.5129

MOTION AMPLITUDES AND PHASES
FN = .446
BETA = 180.0

OMEGA	L/LAM	HEAVE	PHASE	PITCH	PHASE	*PITCH	LAM/L
.9000	.0755	1.16067	-2.847	.28099	-115.143	1.18536	13.2528
1.0000	.0894	1.22374	-5.179	.32236	-120.067	1.14777	11.1857
1.2000	.1193	1.38338	-13.986	.39288	-131.129	1.04840	8.3833
1.3000	.1351	1.46272	-21.324	.41658	-137.651	.98143	7.4013
1.4000	.1515	1.51122	-30.992	.42530	-144.927	.89379	6.6021
1.5000	.1683	1.49437	-42.584	.41207	-152.389	.77933	5.9415
1.6000	.1856	1.39638	-54.865	.37553	-158.573	.64404	5.3879
1.7000	.2033	1.24100	-66.653	.32558	-161.170	.50973	4.9185
1.8000	.2214	1.04885	-77.771	.28774	-158.645	.41365	4.5163
1.9000	.2399	.84293	-86.125	.26980	-155.783	.35799	4.1684
2.0000	.2587	.67483	-91.346	.25467	-153.262	.31332	3.8652
2.2000	.2973	.44398	-97.123	.23378	-147.450	.25028	3.3633
2.4000	.3371	.30008	-99.640	.22109	-142.156	.20877	2.9665
2.7000	.3987	.17273	-100.601	.20716	-135.502	.16539	2.5082
3.0000	.4623	.10280	-101.945	.19661	-130.828	.13536	2.1629
3.5000	.5723	.04424	-122.087	.17127	-130.074	.09526	1.7474

RELATIVE AND ABSOLUTE DISPLACEMENT, VELOCITY, AND ACCELERATION AT STATION 1.0
SPEED = 0.0 KNOTS
WAVE HEADING =135.00 DEGREES

ENC PER(SEC)	REL DISPL	ABS DISPL	VEL	ACCEL/G	WAVE L/L
16.43	1.044	1.673	.640	.008	7.7570
14.78	.795	1.425	.606	.008	6.2832
12.32	.848	1.462	.745	.012	4.3633
11.37	1.084	1.642	.907	.016	3.7179
10.56	1.631	2.047	1.218	.023	3.2057
9.86	2.988	2.956	1.884	.037	2.7925
9.24	3.669	2.734	1.859	.039	2.4544
8.70	2.226	1.620	1.171	.026	2.1741
8.21	.772	.716	.543	.013	1.9393
7.78	.667	.358	.289	.007	1.7405
7.39	.747	.256	.217	.006	1.5708
6.72	.795	.205	.192	.006	1.2982
6.16	.845	.157	.160	.005	1.0908
5.48	.922	.078	.090	.003	.8619
4.93	.964	.037	.048	.002	.6981
4.22	1.012	.013	.019	.001	.5129

SPEED = 20.0 KNOTS
WAVE HEADING =135.00 DEGREES

ENC PER(SEC)	REL DISPL	ABS DISPL	VEL	ACCEL/G	WAVE L/L
16.43	.218	1.212	.464	.006	11.7478
14.78	.317	1.294	.550	.007	9.8475
12.32	.607	1.476	.753	.012	7.2919
11.37	.802	1.552	.857	.015	6.4035
10.56	1.013	1.580	.940	.017	5.6840
9.86	1.204	1.523	.971	.019	5.0918
9.24	1.325	1.361	.926	.020	4.5977
8.70	1.349	1.124	.812	.018	4.1803
8.21	1.300	.888	.679	.016	3.8240
7.78	1.250	.709	.573	.014	3.5171
7.39	1.199	.558	.474	.013	3.2503
6.72	1.096	.337	.315	.009	2.8110
6.16	1.016	.215	.219	.007	2.4656
5.48	.942	.149	.171	.006	2.0694
4.93	.905	.144	.184	.007	1.7731
4.22	.895	.150	.223	.010	1.4194

RELATIVE AND ABSOLUTE DISPLACEMENT, VELOCITY, AND ACCELERATION AT STATION 1.0

SPEED = 0.0 KNOTS
WAVE HEADING =180.00 DEGREES

ENC PER(SEC)	REL DISPL	ABS DISPL	VEL	ACCEL/G	WAVE L/L
16.43	1.427	1.868	.715	.008	7.7570
14.78	1.075	1.497	.636	.008	6.2832
12.32	1.085	1.472	.751	.012	4.3633
11.37	1.324	1.643	.908	.016	3.7179
10.56	1.875	2.042	1.215	.022	3.2057
9.86	3.216	2.958	1.886	.037	2.7925
9.24	3.792	2.818	1.916	.041	2.4544
8.70	2.434	1.778	1.285	.029	2.1741
8.21	1.189	.937	.717	.017	1.9393
7.78	.748	.603	.487	.012	1.7405
7.39	.636	.464	.394	.010	1.5708
6.72	.682	.320	.299	.009	1.2982
6.16	.776	.224	.228	.007	1.0908
5.48	.813	.190	.218	.008	.8619
4.93	.818	.184	.234	.009	.6981
4.22	.943	.057	.085	.004	.5129

SPEED = 20.0 KNOTS
WAVE HEADING =180.00 DEGREES

ENC PER(SEC)	REL DISPL	ABS DISPL	VEL	ACCEL/G	WAVE L/L
16.43	.314	1.298	.496	.006	13.2528
14.78	.439	1.396	.593	.008	11.1857
12.32	.793	1.608	.820	.013	8.3833
11.37	1.020	1.696	.937	.016	7.4013
10.56	1.259	1.735	1.032	.019	6.6021
9.86	1.469	1.685	1.074	.021	5.9415
9.24	1.600	1.534	1.043	.022	5.3879
8.70	1.641	1.310	.947	.021	4.9185
8.21	1.594	1.044	.798	.019	4.5163
7.78	1.483	.791	.638	.016	4.1684
7.39	1.375	.598	.508	.013	3.8652
6.72	1.208	.344	.322	.009	3.3633
6.16	1.095	.203	.207	.007	2.9665
5.48	.994	.122	.140	.005	2.5082
4.93	.945	.122	.156	.006	2.1629
4.22	.938	.132	.197	.009	1.7474

```
MOT35     HEAVE AND PITCH MOTIONS OF   SWATH 6A


DATA INPUT CARDS
         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
 SWATH 6A
    0    2
   0.00000   0.00000
    1    1    2    1    1   19    3    2    0    0
   1.00000
   0.00000
    .44600
  37.50000
   1.00000
  -0.00000
    .50600   3.00000   6.50000
    .15000    .25000
    .05000   1.70000    .10000
 178.14000    .31500    .22300   0.00000   7.44000  11.06000  19.17000  20.00000
  40.44000  25.75000  19.17000   8.50000  10.20000   1.28000   4.38000   1.20000
 188.12000  23.55000  19.17000  14.70000  17.60000   2.20000   3.43000   1.20000
    .50000    .07000   0.00000   0.00000    0   19
   -1.6000   -0.0000   -0.0000   -0.0000    9        -0
    -.8000   -0.0000   -0.0000   -0.0000    9        -0
    0.0000   -0.0000   -0.0000   -0.0000    9        -0
    1.0000   -0.0000   -0.0000   -0.0000    9        -0
    2.0000   -0.0000   -0.0000   -0.0000   15        -0
    3.0000   -0.0000   -0.0000   -0.0000   15        -0
    4.0000   -0.0000   -0.0000   -0.0000   15        -0
    6.0000   -0.0000   -0.0000   -0.0000   15        -0
    8.0000   -0.0000   -0.0000   -0.0000   15         2
   10.0000   -0.0000   -0.0000   -0.0000   15         1
   12.0000   -0.0000   -0.0000   -0.0000   15         1
   14.0000   -0.0000   -0.0000   -0.0000   15         1
   16.0000   -0.0000   -0.0000   -0.0000   15         1
   18.0000   -0.0000   -0.0000   -0.0000   15        -0
   20.0000   -0.0000   -0.0000   -0.0000   15        -0
   22.0000   -0.0000   -0.0000   -0.0000    9        -0
   24.0000   -0.0000   -0.0000   -0.0000    9        -0
   24.5000   -0.0000   -0.0000   -0.0000    9        -0
   25.0000   -0.0000   -0.0000   -0.0000    9        -0
```

SAMPLE RUN 3 - MOT35 OUTPUT (IG = 2) FOR COMPUTER RUN FOR FOLLOWING SEAS AND ONE FROUDE NUMBER

			STATION	-1.6000			
0.0000	-2.0200	-2.7900	-1.9600	0.0000	1.9800	2.8100	2.0000
0.0000							
10.3100	9.4500	7.5100	5.5000	4.7100	5.5300	7.5300	9.5000
10.3100							
			STATION	-.8000			
0.0000	-3.7420	-5.2920	-3.7420	0.0000	3.7420	5.2920	3.7420
0.0000							
12.7920	11.2420	7.5000	3.7580	2.2080	3.7580	7.5000	11.2420
12.7920							
			STATION	0.0000			
0.0000	-4.3800	-6.1100	-4.3000	0.0000	4.3600	6.1400	4.3300
0.0000							
13.6300	11.7800	7.5000	3.1500	1.4000	3.1900	7.5500	11.8400
13.6300							
			STATION	1.0000			
0.0000	-4.8500	-6.7800	-4.7500	0.0000	4.8200	6.8200	4.8200
0.0000							
14.3200	12.2600	7.5300	2.6800	.7300	2.7100	7.5400	12.3000
14.3200							
			STATION	2.0000			
-1.0600	-1.0600	-1.0600	-1.0600	-5.1600	-7.2400	-5.0700	0.0000
5.1100	7.2300	5.1200	1.0600	1.0600	1.0600	1.0600	
26.6800	22.7200	18.7800	14.6800	12.5900	7.5200	2.3900	.3400
2.4300	7.5600	12.6500	14.6800	18.7800	22.7200	26.6800	
			STATION	3.0000			
-2.1700	-2.1700	-2.1700	-2.1700	-5.3200	-7.4400	-5.2000	0.0000
5.2400	7.4200	5.2400	2.1700	2.1700	2.1700	2.1700	
26.6600	22.6400	18.6400	14.6200	12.7200	7.5200	2.2500	.1100
2.2900	7.5600	12.7900	14.6200	18.6400	22.6400	26.6600	
			STATION	4.0000			
-3.0000	-3.0000	-3.0000	-3.0000	-5.3600	-7.5300	-5.2800	0.0000
5.3100	7.5000	5.3000	3.0000	3.0000	3.0000	3.0000	
26.6600	22.5700	18.4600	14.3700	12.7700	7.5000	2.1800	0.0000
2.2300	7.5600	12.8400	14.3700	18.4600	22.5700	26.6600	
			STATION	6.0000			
-3.5600	-3.5600	-3.5600	-3.5600	-5.3700	-7.5300	-5.2700	0.0000
5.3400	7.5600	5.3700	3.5600	3.5600	3.5600	3.5600	
26.6400	22.4800	18.3200	14.1600	12.7900	7.5200	2.1700	0.0000
2.1800	7.5500	12.8500	14.1600	18.3200	22.4800	26.6400	
			STATION	8.0000			
-3.6200	-3.6200	-3.6200	-3.6200	-5.3700	-7.5300	-5.2700	0.0000
5.3400	7.5600	5.3700	3.6200	3.6200	3.6200	3.6200	
26.6400	22.4600	18.2800	14.1100	12.7900	7.5200	2.1700	0.0000
2.1800	7.5500	12.8500	14.1100	18.2800	22.4600	26.6400	
			STATION	10.0000			
-3.6200	-3.6200	-3.6200	-3.6200	-5.3700	-7.5300	-5.2700	0.0000
5.3400	7.5600	5.3700	3.6200	3.6200	3.6200	3.6200	
26.6400	22.4600	18.2800	14.1100	12.7900	7.5200	2.1700	0.0000
2.1800	7.5500	12.8500	14.1100	18.2800	22.4600	26.6400	

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                                        STATION     12.0000
 -3.6200  -3.6200  -3.6200  -3.6200  -5.3700  -7.5300  -5.2700   0.0000
  5.3400   7.5600   5.3700   3.6200   3.6200   3.6200   3.6200
 26.6400  22.4600  18.2800  14.1100  12.7900   7.5200   2.1700   0.0000
  2.1800   7.5500  12.8500  14.1100  18.2800  22.4600  26.6400
                                        STATION     14.0000
 -3.6200  -3.6200  -3.6200  -3.6200  -5.3700  -7.5300  -5.2700   0.0000
  5.3400   7.5600   5.3700   3.6200   3.6200   3.6200   3.6200
 26.6400  22.4600  18.2800  14.1100  12.7900   7.5200   2.1700   0.0000
  2.1800   7.5500  12.8500  14.1100  18.2800  22.4600  26.6400
                                        STATION     16.0000
 -3.6100  -3.6100  -3.6100  -3.6100  -5.3700  -7.5300  -5.2700   0.0000
  5.3400   7.5600   5.3700   3.6100   3.6100   3.6100   3.6100
 26.7000  22.5200  18.3400  14.1500  12.7900   7.5200   2.1700   0.0000
  2.1800   7.5500  12.8500  14.1500  18.3400  22.5200  26.7000
                                        STATION     18.0000
 -3.1100  -3.1100  -3.1100  -3.1100  -5.3000  -7.4800  -5.2500   0.0000
  5.3300   7.4900   5.2700   3.1100   3.1100   3.1100   3.1100
 26.6800  22.5700  18.4500  14.3400  12.8200   7.5400   2.2400   0.0000
  2.2700   7.5700  12.8200  14.3400  18.4500  22.5700  26.6800
                                        STATION     20.0000
 -1.4300  -1.4300  -1.4300  -1.4300  -5.0100  -7.1000  -4.9800   0.0000
  5.0600   7.1100   5.0100   1.4300   1.4300   1.4300   1.4300
 26.6900  22.6100  18.5300  14.4600  12.5200   7.5500   2.5000    .4500
  2.5500   7.5700  12.5500  14.4600  18.5300  22.6100  26.6900
                                        STATION     22.0000
  0.0000  -4.3500  -6.1600  -4.3400   0.0000   4.3900   6.1600   4.3600
  0.0000
 13.6800  11.8800   7.5400   3.1600   1.3800   3.2100   7.5600  11.9000
 13.6800
                                        STATION     24.0000
  0.0000  -3.2500  -4.5700  -3.2300   0.0000   3.2800   4.6100   3.2500
  0.0000
 12.1100  10.7800   7.5400   4.2800   2.9400   4.3100   7.5700  10.7800
 12.1100
                                        STATION     24.5000
  0.0000  -2.6500  -3.7800  -2.6500   0.0000   2.7000   3.7800   2.6600
  0.0000
 11.7400  10.5100   7.5200   4.5200   3.2800   4.5200   7.5200  10.5100
 11.7400
                                        STATION     25.0000
  0.0000  -2.7390  -3.8740  -2.7390   0.0000   2.7390   3.8740   2.7390
  0.0000
 11.3740  10.2400   7.5000   4.7600   3.6260   4.7600   7.5000  10.2400
 11.3740
```

STATION	BEAM	DRAFT	AREA COEFFICIENT
-1.6000	0.0000	5.6000	.7089
-.8000	0.0000	10.5840	.7071
0.0000	0.0000	12.2300	.7089
1.0000	0.0000	13.5900	.7068
2.0000	2.1200	26.3400	3.1311
3.0000	4.3400	26.5500	1.8257
4.0000	6.0000	26.6600	1.4655
6.0000	7.1200	26.6400	1.3154
8.0000	7.2400	26.6400	1.3013
10.0000	7.2400	26.6400	1.3013
12.0000	7.2400	26.6400	1.3013
14.0000	7.2400	26.6400	1.3013
16.0000	7.2200	26.7000	1.3032
18.0000	6.2200	26.6800	1.4244
20.0000	2.8600	26.2400	2.3867
22.0000	0.0000	12.3000	.7089
24.0000	0.0000	9.1700	.7087
24.5000	0.0000	8.4600	.6314
25.0000	0.0000	7.7480	.7072

CRITICAL ENC. FREQ. FOR STATION -1.6000 = 0.0000
CRITICAL ENC. FREQ. FOR STATION -.8000 = 0.0000
CRITICAL ENC. FREQ. FOR STATION 0.0000 = 0.0000
CRITICAL ENC. FREQ. FOR STATION 1.0000 = 0.0000
CRITICAL ENC. FREQ. FOR STATION 2.0000 = 16.2475
CRITICAL ENC. FREQ. FOR STATION 3.0000 = 11.3556
CRITICAL ENC. FREQ. FOR STATION 4.0000 = 9.6578
CRITICAL ENC. FREQ. FOR STATION 6.0000 = 8.8658
CRITICAL ENC. FREQ. FOR STATION 8.0000 = 8.7920
CRITICAL ENC. FREQ. FOR STATION 10.0000 = 8.7920
CRITICAL ENC. FREQ. FOR STATION 12.0000 = 8.7920
CRITICAL ENC. FREQ. FOR STATION 14.0000 = 8.7920
CRITICAL ENC. FREQ. FOR STATION 16.0000 = 8.8041
CRITICAL ENC. FREQ. FOR STATION 18.0000 = 9.4855
CRITICAL ENC. FREQ. FOR STATION 20.0000 = 13.9885
CRITICAL ENC. FREQ. FOR STATION 22.0000 = 0.0000
CRITICAL ENC. FREQ. FOR STATION 24.0000 = 0.0000
CRITICAL ENC. FREQ. FOR STATION 24.5000 = 0.0000
CRITICAL ENC. FREQ. FOR STATION 25.0000 = 0.0000

MINIMUM CRITICAL ENC. FREQ. = 0.0000 DUE TO STATION 25.0000

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                          DATA FOR ONE HULL

      LENGTH BETWEEN PERPENDICULARS =  178.14000 FEET
                    BEAM AT MIDSHIP =    7.24000 FEET
                   DRAFT AT MIDSHIP =   26.64000 FEET
                       DISPLACEMENT =   1289.648 LONG TONS
                  BLOCK COEFFICIENT =    1.34741
   LONGITUDINAL CENTER OF BUOYANCY =  100.37494 FEET AFT OF F.P.
   LONGITUDINAL CENTER OF BUOYANCY =   11.26922 STATIONS
  LONGITUDINAL CENTER OF FLOTATION =   99.66327 FEET AFT OF F.P.
  LONGITUDINAL CENTER OF FLOTATION =   11.18932 STATIONS
  VERTICAL CENTER OF BUOYANCY        =   15.46576FEET FROM THE DESIGNED LOAD WATERLINE
           RADIUS OF GYRATION/L.B.P. =      .31500
                         BEAM/DRAFT =      .27177
                        LENGTH/BEAM =   24.60497

   THE HEAVE-HEAVE RESTORING COEFFICIENT IS     4.12036
   THE HEAVE-PITCH RESTORING COEFFICIENT IS     -.01646
   THE PITCH-PITCH RESTORING COEFFICIENT IS      .12559
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      BETA =          0.0

      QUARTERING SEA  KASE=1 ,HIGH FREQUENCY WAVES FASTER THAN SHIP

               SPEED RANGE OF INTEREST FROM FROUDE NUMBER   .1608 TO   .9476

      AT FROUDE NUMBER=  .4460 FREQUENCY RANGE IS   .0500 TO   .5605 AND WAVE LENGTH RANGE IS  1.3089 TO  4.9993

    ANALYSIS WILL BE BASED ON 16 FREQUENCIES  FROM   .0500 TO   .5605

   PROJECTED AREA OF THE SUBMERGED HULL/L**2 =     .103721E+00
  MOMENT/L**3 =    .101487E-02     MOMENT OF INERTIA/L**4 =    .135252E-01
```

HULL SEPARATION/BEAM = 9.3591

DYNAMIC COEFFICIENTS OF THE EQUATIONS OF MOTION

A33 IS SCALED BY M.

A35 AND A53 ARE SCALED BY M*L.

A55 IS SCALED BY M*L*L.

B33 IS SCALED BY M*SQRT(G/L).

B35 AND B53 ARE SCALED BY M*SQRT(G*L).

B55 IS SCALED BY M*L*SQRT(G*L).

M IS THE DISPLACED MASS.

G IS THE ACCELERATION DUE TO GRAVITY.

L IS THE DISTANCE BETWEEN PERPENDICULARS.

FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT(G*L).

BETA IS THE WAVE HEADING ANGLE IN DEGREES.
BETA = 180. FOR HEAD SEAS.

OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED BYSQRT(G/L).

THE HULL SEPARATION/BEAM RATIO IS THE DISTANCE
BETWEEN THE HULLS DIVIDED BY THE BEAM OF ONE HULL.

MOT35 HEAVE AND PITCH MOTIONS OF SWATH 6A

HULL SEPARATION/BEAM = 9.3591

BARE HULL POTENTIAL FLOW ADDED MASS AND DAMPING COEFFICIENTS

FN = .446

OMEGA	A33	A35	A53	A55	B33	B35	B53	B55
.0500	1.380747	-3.405210	3.404081	109.989945	.019084	.615738	-.615888	1.519494
.1698	1.074671	-.981018	.982319	7.525488	.063472	.479054	-.479552	.441220
.2566	.966948	-.631597	.633759	3.028796	.093375	.430895	-.431622	.287161
.3214	.906757	-.490939	.493582	1.849588	.114015	.403973	-.404854	.225625
.3710	.867969	-.415342	.418293	1.355619	.128659	.386621	-.387607	.192746
.4097	.841065	-.368568	.371731	1.096719	.139315	.374585	-.375646	.172488
.4403	.821536	-.337129	.340445	.942101	.147243	.365848	-.366963	.158913
.4647	.806904	-.314831	.318262	.841634	.153251	.359302	-.360457	.149305
.4843	.795698	-.298421	.301938	.772475	.157874	.354289	-.355474	.142244
.5002	.786977	-.286024	.289609	.722871	.161476	.350388	-.351596	.136916
.5131	.780112	-.276483	.280121	.686223	.164309	.347317	-.348543	.132818
.5307	.771100	-.264239	.267945	.641111	.168016	.343286	-.344535	.127563
.5427	.765[illegible]90	-.256243	.259995	.612803	.170476	.340599	-.341862	.124133
.5509	.761105	-.251014	.254796	.594779	.172100	.338816	-.340089	.121891
.5562	.758548	-.247689	.251491	.583515	.173138	.337673	-.338952	.120466
.5605	.756494	-.245035	.248852	.574633	.173969	.336755	-.338038	.119328

HULL SEPARATION/BEAM = 9.3591

DAMPING COEFFICIENTS INCLUDING CROSS-FLOW DRAG
FN = .446

BETA = 0.0

OMEGA	B33	B35	B53	B55
.0500	1.325346	.924259	-.386364	1.770048
.1698	1.366794	.787023	-.250582	.691325
.2566	1.394802	.738752	-.202763	.536952
.3214	1.413887	.711907	-.175918	.475145
.3710	1.427269	.694679	-.158547	.442036
.4097	1.436925	.682756	-.146472	.421590
.4403	1.444075	.674098	-.137711	.407862
.4647	1.449483	.667589	-.131168	.398133
.4843	1.453643	.662575	-.126186	.390979
.5002	1.456883	.658639	-.122342	.385580
.5131	1.459436	.655505	-.119352	.381431
.5307	1.462777	.651308	-.115511	.376126
.5427	1.464979	.648413	-.113045	.372685
.5509	1.466343	.646439	-.111464	.370434
.5562	1.467088	.645135	-.110487	.368991
.5605	1.467172	.643944	-.109847	.367789

HULL SEPARATION/BEAM = 9.3591

ADDED MASS COEFFICIENTS AND DAMPING COEFFICIENTS EXCLUDING CROSS-FLOW DRAG
FN = .446

OMEGA	A33	A35	A53	A55	B33	B35	B53	B55
.0500	1.469309	-3.373513	3.435779	117.056174	1.304121	.922612	-.388012	1.766909
.1698	1.163234	-.949321	1.014016	8.156010	1.348508	.785928	-.251676	.688634
.2566	1.055510	-.599900	.665457	3.316052	1.378412	.737769	-.203746	.534575
.3214	.995320	-.459242	.525279	2.039750	1.399052	.710847	-.176978	.473039
.3710	.956531	-.383645	.449990	1.503209	1.413695	.693495	-.159731	.440160
.4097	.929628	-.336870	.403428	1.221289	1.424351	.681458	-.147770	.419903
.4403	.910099	-.305432	.372143	1.052608	1.432279	.672721	-.139087	.406327
.4647	.895467	-.283133	.349959	.942846	1.438287	.666176	-.132581	.396719
.4843	.884261	-.266724	.333636	.867203	1.442911	.661163	-.127598	.389658
.5002	.875539	-.254327	.321306	.812899	1.446513	.657261	-.123720	.384330
.5131	.868674	-.244786	.311818	.772751	1.449346	.654191	-.120667	.380232
.5307	.859662	-.232542	.299642	.723291	1.453053	.650160	-.116659	.374977
.5427	.853652	-.224546	.291692	.692233	1.455513	.647472	-.113986	.371547
.5509	.849667	-.219317	.286494	.672449	1.457136	.645690	-.112213	.369305
.5562	.847111	-.215992	.283188	.660081	1.458174	.644547	-.111076	.367880
.5605	.845057	-.213338	.280549	.650326	1.459006	.643629	-.110162	.366742

1

HULL SEPARATION/BEAM = 9.3591

EXCITING FORCE, MOMENT AND PHASES

THE FORCE AMPLITUDE IS SCALED BY THE HEAVE RESTORING FORCE
C33 = RHO*G*A*(WATERPLANE AREA).

THE MOMENT AMPLITUDE IS SCALED BY THE PITCH RESTORING MOMENT
C55 = RHO*G*A*(MOMENT OF INERTIA OF WATERPLANE)/L.

MOMENT DENOTES THE MOMENT AMPLITUDE SCALED BY L(WAVE NUMBER)*C55.

G IS THE ACCELERATION DUE TO GRAVITY.

A IS THE WAVE AMPLITUDE.

L IS THE DISTANCE BETWEEN PERPENDICULARS.

RHO IS THE WATER DENSITY.

FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT(G*L).

BETA IS THE WAVE HEADING ANGLE IN DEGREES.
BETA = 180. FOR HEAD SEAS.

OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED BY SQRT(G/L).

THE PHASE ANGLE IS MEASURED IN DEGREES WITH RESPECT TO THE WAVE AT THE CG.

L/LAM IS L/(WAVE LENGTH).

FOR FOLLOWING SEAS THE FREQUENCY DOMAIN IS DIVIDED INTO THREE
REGIONS SEPARATED BY TWO CRITICAL L/LAM DENOTED CWR1 AND CWR2.

HULL SEPARATION/BEAM = 9.3591

EXCITING FORCE, MOMENT AND PHASES
FN = .446
BETA = 0.0
REGION 1CWR1 = .2000 CWR2 = .8001

OMEGA	L/LAM	FORCE	PHASE	MOMENT	PHASE	*MOMENT	LAM/L
.0500	.7640	.25388	-42.788	2.80456	-148.638	.58423	1.3089
.1698	.6735	.18962	-27.127	3.12781	-154.316	.73917	1.4849
.2566	.6031	.16767	-4.070	3.26700	-157.561	.86214	1.6581
.3214	.5467	.18335	15.709	3.28062	-160.169	.95512	1.8293
.3710	.5003	.21682	27.300	3.22376	-162.451	1.02562	1.9990
.4097	.4614	.25457	33.213	3.12989	-164.510	1.07970	2.1675
.4403	.4283	.29139	36.054	3.01851	-166.396	1.12180	2.3351
.4547	.3997	.32570	37.260	2.90078	-168.133	1.15512	2.5020
.4843	.3747	.35720	37.572	2.78300	-169.740	1.18195	2.6685
.5002	.3528	.38600	37.381	2.66862	-171.230	1.20394	2.8346
.5131	.3333	.41237	36.904	2.55942	-172.611	1.22228	3.0006
.5307	.3030	.45464	35.688	2.37768	-174.858	1.24880	3.3000
.5427	.2777	.49141	34.295	2.21516	-176.835	1.26968	3.6014
.5509	.2559	.52396	32.873	2.06930	-178.588	1.28697	3.9077
.5562	.2367	.55350	31.465	1.93623	179.832	1.30211	4.2254
.5605	.2000	.61188	28.449	1.67429	176.813	1.33217	4.9993

HULL SEPARATION/BEAM = 9.3591

MOTION AMPLITUDES AND PHASES

THE HEAVE AMPLITUDE IS SCALED BY A.

THE PITCH AMPLITUDE IS SCALED BY 2*A/L.

PITCH DENOTES PITCH AMPLITUDE SCALED BY A(WAVE NUMBER).

A IS THE WAVE AMPLITUDE.

FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT(G*L).

BETA IS THE WAVE HEADING ANGLE IN DEGREES.
BETA = 180. FOR HEAD SEAS.

OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED BY SQRT(G/L).

THE PHASE ANGLE IS MEASURED IN DEGREES WITH RESPECT TO THE WAVE AT THE CG.

L/LAM IS L/(WAVE LENGTH).

FOR FOLLOWING SEAS THE FREQUENCY DOMAIN IS DIVIDED INTO THREE
REGIONS SEPARATED BY TWO CRITICAL L/LAM DENOTED CWR1 AND CWR2.

HULL SEPARATION/BEAM = 9.3591

MOTION AMPLITUDES AND PHASES
FN = .446
BETA = 0.0
REGION1 CWR1 = .2000 CWR2 = .8001

OMEGA	L/LAM	HEAVE	PHASE	PITCH	PHASE	*PITCH	LAM/L
.0500	.7640	1.16994	-73.100	3.47110	95.654	1.44617	1.3089
.1698	.6735	1.10539	-45.681	3.12530	121.551	1.47716	1.4849
.2566	.6031	.99549	-38.899	2.71776	122.818	1.43439	1.6581
.3214	.5467	.92460	-35.612	2.43932	120.558	1.42036	1.8293
.3710	.5003	.87285	-33.334	2.22167	117.566	1.41362	1.9990
.4097	.4614	.83297	-31.407	2.04079	114.504	1.40799	2.1675
.4403	.4283	.80177	-29.614	1.88626	111.564	1.40202	2.3351
.4647	.3997	.77746	-27.886	1.75226	108.804	1.39553	2.5020
.4843	.3747	.75878	-26.208	1.63497	106.234	1.38875	2.6685
.5002	.3528	.74473	-24.586	1.53155	103.845	1.38190	2.8346
.5131	.3333	.73451	-23.033	1.43981	101.623	1.37519	3.0006
.5307	.3030	.72360	-20.436	1.29838	97.989	1.36386	3.3000
.5427	.2777	.71975	-18.121	1.18099	94.753	1.35384	3.6014
.5509	.2559	.72076	-16.079	1.08150	91.828	1.34525	3.9077
.5562	.2367	.72518	-14.272	.99483	89.118	1.33803	4.2254
.5605	.2000	.74300	-10.948	.83378	83.595	1.32682	4.9993

RELATIVE AND ABSOLUTE DISPLACEMENT, VELOCITY, AND ACCELERATION AT STATION 1.0
SPEED = 20.0 KNOTS
WAVE HEADING = 0.00 DEGREES

ENC PER(SEC)	REL DISPL	ABS DISPL	VEL	ACCEL/G	WAVE L/L
295.69	4.300	4.718	.100	.000	1.3089
87.06	4.050	4.294	.310	.001	1.4849
57.63	3.347	3.749	.409	.001	1.6581
46.00	2.802	3.372	.461	.002	1.8293
39.85	2.367	3.074	.485	.002	1.9990
36.09	2.013	2.824	.492	.003	2.1675
33.58	1.723	2.611	.488	.003	2.3351
31.82	1.484	2.425	.479	.003	2.5020
30.53	1.288	2.261	.465	.003	2.6685
29.56	1.125	2.118	.450	.003	2.8346
28.81	.990	1.990	.434	.003	3.0006
27.86	.804	1.794	.405	.003	3.3000
27.24	.671	1.633	.377	.003	3.6014
26.84	.577	1.498	.351	.003	3.9077
26.58	.510	1.383	.327	.002	4.2254
26.38	.424	1.177	.280	.002	4.9993

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MOT35    HEAVE AND PITCH MOTIONS OF   SWATH 6A                                                    PAGE    16

      BETA =          0.0

      QUARTERING SEA  KASE=2, LOW FREQUENCY WAVES FASTER THAN SHIP

            SPEED RANGE OF INTEREST FROM FROUDE NUMBER   .0000 TO   .4987

      AT FROUDE NUMBER=  .4460 FREQUENCY RANGE IS   .5521 TO   .5605 AND WAVE LENGTH RANGE IS  4.9993 TO  6.5000

   ANALYSIS WILL BE BASED ON  4 FREQUENCIES  FROM   .5521 TO   .5605

    PROJECTED AREA OF THE SUBMERGED HULL/L**2 =    .103721E+00
   MOMENT/L**3 =    .101487E-02     MOMENT OF INERTIA/L**4 =    .135252E-01

MOT35    HEAVE AND PITCH MOTIONS OF   SWATH 6A                                                    PAGE    17

                                                                 HULL SEPARATION/BEAM =  9.3591
    DYNAMIC COEFFICIENTS OF THE EQUATIONS OF MOTION

    A33 IS SCALED BY M.

    A35 AND A53 ARE SCALED BY M*L.

    A55 IS SCALED BY M*L*L.

    B33 IS SCALED BY M*SQRT(G/L).

    B35 AND B53 ARE SCALED BY M*SQRT(G*L).

    B55 IS SCALED BY M*L*SQRT(G*L).

    M IS THE DISPLACED MASS.

    G IS THE ACCELERATION DUE TO GRAVITY.

    L IS THE DISTANCE BETWEEN PERPENDICULARS.

    FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT(G*L).

    BETA IS THE WAVE HEADING ANGLE IN DEGREES.
    BETA = 180. FOR HEAD SEAS.

    OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED BYSQRT(G/L).

    THE HULL SEPARATION/BEAM RATIO IS THE DISTANCE
    BETWEEN THE HULLS DIVIDED BY THE BEAM OF ONE HULL.
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MOT35 HEAVE AND PITCH MOTIONS OF SWATH 6A PAGE 18

HULL SEPARATION/BEAM = 9.3591

BARE HULL POTENTIAL FLOW ADDED MASS AND DAMPING COEFFICIENTS
FN = .446

OMEGA	A33	A35	A53	A55	B33	B35	B53	B55
.5521	.760549	-.250290	.254076	.592312	.172326	.338568	-.339842	.121581
.5552	.759059	-.248352	.252150	.585749	.172930	.337902	-.339179	.120750
.5583	.757578	-.246435	.250243	.579304	.173530	.337239	-.338520	.119928
.5605	.756494	-.245035	.248852	.574633	.173969	.336755	-.338038	.119328

MOT35 HEAVE AND PITCH MOTIONS OF SWATH 6A PAGE 19

HULL SEPARATION/BEAM = 9.3591

ADDED MASS COEFFICIENTS AND DAMPING COEFFICIENTS EXCLUDING CROSS-FLOW DRAG
FN = .446

OMEGA	A33	A35	A53	A55	B33	B35	B53	B55
.5521	.849112	-.218593	.285773	.669740	1.457362	.645442	-.111966	.368995
.5552	.847622	-.216655	.283847	.662533	1.457967	.644776	-.111303	.368164
.5583	.846141	-.214738	.281940	.655456	1.458567	.644113	-.110644	.367342
.5605	.845057	-.213338	.280549	.650326	1.459006	.643629	-.110162	.366742

ITERATION NOT USED. MAX AMP = .78243E+00

0

MOT35 HEAVE AND PITCH MOTIONS OF SWATH 6A PAGE 20

HULL SEPARATION/BEAM = 9.3591

DAMPING COEFFICIENTS INCLUDING CROSS-FLOW DRAG
FN = .446

BETA = 0.0

OMEGA	B33	B35	B53	B55
.5521	1.457362	.645442	-.111966	.368995
.5552	1.457967	.644776	-.111303	.368164
.5583	1.458567	.644113	-.110644	.367342
.5605	1.459006	.643629	-.110162	.366742

HULL SEPARATION/BEAM = 9.3591

EXCITING FORCE, MOMENT AND PHASES

THE FORCE AMPLITUDE IS SCALED BY THE HEAVE RESTORING FORCE
C33 = RHO*G*A*(WATERPLANE AREA).

THE MOMENT AMPLITUDE IS SCALED BY THE PITCH RESTORING MOMENT
C55 = RHO*G*A*(MOMENT OF INERTIA OF WATERPLANE)/L.

MOMENT DENOTES THE MOMENT AMPLITUDE SCALED BY L(WAVE NUMBER)*C55.

G IS THE ACCELERATION DUE TO GRAVITY.

A IS THE WAVE AMPLITUDE.

L IS THE DISTANCE BETWEEN PERPENDICULARS.

RHO IS THE WATER DENSITY.

FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT(G*L).

BETA IS THE WAVE HEADING ANGLE IN DEGREES.
BETA = 180. FOR HEAD SEAS.

OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED BY SQRT(G/L).

THE PHASE ANGLE IS MEASURED IN DEGREES WITH RESPECT TO THE WAVE AT THE CG.

L/LAM IS L/(WAVE LENGTH).

FOR FOLLOWING SEAS THE FREQUENCY DOMAIN IS DIVIDED INTO THREE
REGIONS SEPARATED BY TWO CRITICAL L/LAM DENOTED CWR1 AND CWR2.

HULL SEPARATION/BEAM = 9.3591

EXCITING FORCE, MOMENT AND PHASES
FN = .446
BETA = 0.0
REGION 2CWR1 = .2000 CWR2 = .3001

OMEGA	L/LAM	FORCE	PHASE	MOMENT	PHASE	*MOMENT	LAM/L
.5521	.1538	.68925	24.035	1.32998	173.326	1.37587	6.5000
.5552	.1627	.67379	24.876	1.39614	173.940	1.36531	6.1444
.5583	.1753	.65230	26.671	1.48898	174.868	1.35175	5.7041
.5605	.2000	.61113	28.301	1.66946	175.835	1.32833	4.9993

HULL SEPARATION/BEAM = 9.3591

MOTION AMPLITUDES AND PHASES

THE HEAVE AMPLITUDE IS SCALED BY A.

THE PITCH AMPLITUDE IS SCALED BY 2*A/L.

PITCH DENOTES PITCH AMPLITUDE SCALED BY A(WAVE NUMBER).

A IS THE WAVE AMPLITUDE.

FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT(G*L).

BETA IS THE WAVE HEADING ANGLE IN DEGREES.
BETA = 180. FOR HEAD SEAS.

OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED BY SQRT(G/L).

THE PHASE ANGLE IS MEASURED IN DEGREES WITH RESPECT TO THE WAVE AT THE CG.

L/LAM IS L/(WAVE LENGTH).

FOR FOLLOWING SEAS THE FREQUENCY DOMAIN IS DIVIDED INTO THREE
REGIONS SEPARATED BY TWO CRITICAL L/LAM DENOTED CWR1 AND CWR2.

HULL SEPARATION/BEAM = 9.3591

MOTION AMPLITUDES AND PHASES
FN = .446
BETA = 0.0
REGION2 CWR1 = .2000 CWR2 = .8001

OMEGA	L/LAM	HEAVE	PHASE	PITCH	PHASE	*PITCH	LAM/L
.5521	.1538	.78243	-7.390	.63942	75.789	1.32296	6.5000
.5552	.1627	.77344	-7.980	.67591	77.376	1.32196	6.1444
.5583	.1753	.76186	-8.938	.72809	79.546	1.32197	5.7041
.5605	.2000	.74307	-11.007	.83301	83.599	1.32560	4.9993

RELATIVE AND ABSOLUTE DISPLACEMENT, VELOCITY, AND ACCELERATION AT STATION 1.0
SPEED = 20.0 KNOTS
WAVE HEADING = 0.00 DEGREES

ENC PER(SEC)	REL DISPL	ABS DISPL	VEL	ACCEL/G	WAVE L/L
26.78	.371	.959	.225	.002	6.5000
26.63	.378	.996	.235	.002	6.1444
26.48	.391	1.053	.250	.002	5.7041
26.38	.424	1.177	.280	.002	4.9993

BETA = 0.0

QUARTERING SEA KASE=3 , SHIP FASTER THAN WAVES

SPEED RANGE OF INTEREST FROM FROUDE NUMBER .3787 TO 1.5549

AT FROUDE NUMBER= .4460 FREQUENCY RANGE IS .5521 TO .5605 AND WAVE LENGTH RANGE IS .8577 TO .8616

ANALYSIS WILL BE BASED ON 2 FREQUENCIES FROM .5521 TO .5605

PROJECTED AREA OF THE SUBMERGED HULL/L**2 = .103721E+00
MOMENT/L**3 = .101487E-02 MOMENT OF INERTIA/L**4 = .135252E-01

HULL SEPARATION/BEAM = 9.3591

DYNAMIC COEFFICIENTS OF THE EQUATIONS OF MOTION

A33 IS SCALED BY M.

A35 AND A53 ARE SCALED BY M*L.

A55 IS SCALED BY M*L*L.

B33 IS SCALED BY M*SQRT(G/L).

B35 AND B53 ARE SCALED BY M*SQRT(G*L).

B55 IS SCALED BY M*L*SQRT(G*L).

M IS THE DISPLACED MASS.

G IS THE ACCELERATION DUE TO GRAVITY.

L IS THE DISTANCE BETWEEN PERPENDICULARS.

FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT(G*L).

BETA IS THE WAVE HEADING ANGLE IN DEGREES.
BETA = 180. FOR HEAD SEAS.

OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED BYSQRT(G/L).

THE HULL SEPARATION/BEAM RATIO IS THE DISTANCE
BETWEEN THE HULLS DIVIDED BY THE BEAM OF ONE HULL.

HULL SEPARATION/BEAM = 9.3591

BARE HULL POTENTIAL FLOW ADDED MASS AND DAMPING COEFFICIENTS
FN = .446

OMEGA	A33	A35	A53	A55	B33	B35	B53	B55
.5521	.760549	-.250290	.254076	.592312	.172326	.338568	-.339842	.121581
.5605	.756494	-.245035	.248852	.574633	.173969	.336755	-.338038	.119328

HULL SEPARATION/BEAM = 9.3591

ADDED MASS COEFFICIENTS AND DAMPING COEFFICIENTS EXCLUDING CROSS-FLOW DRAG
FN = .446

OMEGA	A33	A35	A53	A55	B33	B35	B53	B55
.5521	.849112	-.218593	.285773	.669740	1.457362	.645442	-.111966	.368995
.5605	.845057	-.213338	.280549	.650326	1.459006	.643629	-.110162	.366742

ITERATION NOT USED. MAX AMP = .34850E+00
0

HULL SEPARATION/BEAM = 9.3591

DAMPING COEFFICIENTS INCLUDING CROSS-FLOW DRAG
FN = .446

BETA = 0.0

OMEGA	B33	B35	B53	B55
.5521	1.457362	.645442	-.111966	.368995
.5605	1.459006	.643629	-.110162	.366742

MOT35 HEAVE AND PITCH MOTIONS OF SWATH 6A PAGE 31

HULL SEPARATION/BEAM = 9.3591

EXCITING FORCE, MOMENT AND PHASES

THE FORCE AMPLITUDE IS SCALED BY THE HEAVE RESTORING FORCE
C33 = RHO*G*A*(WATERPLANE AREA).

THE MOMENT AMPLITUDE IS SCALED BY THE PITCH RESTORING MOMENT
C55 = RHO*G*A*(MOMENT OF INERTIA OF WATERPLANE)/L.

MOMENT DENOTES THE MOMENT AMPLITUDE SCALED BY L(WAVE NUMBER)*C55.

G IS THE ACCELERATION DUE TO GRAVITY.

A IS THE WAVE AMPLITUDE.

L IS THE DISTANCE BETWEEN PERPENDICULARS.

RHO IS THE WATER DENSITY.

FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT(G*L).

BETA IS THE WAVE HEADING ANGLE IN DEGREES.
BETA = 180. FOR HEAD SEAS.

OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED BY SQRT(G/L).

THE PHASE ANGLE IS MEASURED IN DEGREES WITH RESPECT TO THE WAVE AT THE CG.

L/LAM IS L/(WAVE LENGTH).

FOR FOLLOWING SEAS THE FREQUENCY DOMAIN IS DIVIDED INTO THREE
REGIONS SEPARATED BY TWO CRITICAL L/LAM DENOTED CWR1 AND CWR2.

MOT35 HEAVE AND PITCH MOTIONS OF SWATH 6A PAGE 32

HULL SEPARATION/BEAM = 9.3591

EXCITING FORCE, MOMENT AND PHASES
FN = .446
BETA = 0.0
REGION 3CWR1 = .2000 CWR2 = .5001

OMEGA	L/LAM	FORCE	PHASE	MOMENT	PHASE	*MOMENT	LAM/L
.5521	1.1607	.41535	-42.361	.42324	42.971	.05804	.8616
.5505	1.1658	.41478	-42.199	.46838	43.080	.06394	.8577

MOT35 HEAVE AND PITCH MOTIONS OF SWATH 6A PAGE 33

HULL SEPARATION/BEAM = 9.3591

MOTION AMPLITUDES AND PHASES

THE HEAVE AMPLITUDE IS SCALED BY A.

THE PITCH AMPLITUDE IS SCALED BY 2*A/L.

PITCH DENOTES PITCH AMPLITUDE SCALED BY A(WAVE NUMBER).

A IS THE WAVE AMPLITUDE.

FN IS THE FROUDE NUMBER = (FORWARD SPEED)/SQRT(G*L).

BETA IS THE WAVE HEADING ANGLE IN DEGREES.
BETA = 180. FOR HEAD SEAS.

OMEGA IS THE ENCOUNTER FREQUENCY NON-DIMENSIONALIZED BY SQRT(G/L).

THE PHASE ANGLE IS MEASURED IN DEGREES WITH RESPECT TO THE WAVE AT THE CG.

L/LAM IS L/(WAVE LENGTH).

FOR FOLLOWING SEAS THE FREQUENCY DOMAIN IS DIVIDED INTO THREE
REGIONS SEPARATED BY TWO CRITICAL L/LAM DENOTED CWR1 AND CWR2.

MOT35 HEAVE AND PITCH MOTIONS OF SWATH 6A PAGE 34

HULL SEPARATION/BEAM = 9.3591

MOTION AMPLITUDES AND PHASES
FN = .446
BETA = 0.0
REGION3 CWR1 = .2000 CWR2 = .8001

OMEGA	L/LAM	HEAVE	PHASE	PITCH	PHASE	*PITCH	LAM/L
.5521	1.1607	.34850	-58.609	.31316	-62.177	.08588	.8616
.5605	1.1658	.34128	-59.556	.33428	-60.984	.09127	.8577

MOT35 HEAVE AND PITCH MOTIONS OF SWATH 6A PAGE 35

RELATIVE AND ABSOLUTE DISPLACEMENT, VELOCITY, AND ACCELERATION AT STATION 1.0
SPEED = 20.0 KNOTS
WAVE HEADING = 0.00 DEGREES

ENC PER(SEC)	REL DISPL	ABS DISPL	VEL	ACCEL/G	WAVE L/L
26.78	1.033	.034	.008	.000	.8616
26.38	1.002	.009	.002	.000	.8577

APPENDIX F

PROGRAM FOR IRREGULAR SEA CALCULATIONS

Irregular-sea calculations can be made for any wave heading with the use of transfer functions from MOT246 and MOT35 and the Center's SMOTION program. The program SMOTION is used to calculate ship responses using the Pierson-Moskowitz formula as well as results of spectral analysis of 323 samples of real sea conditions measured at Station INDIA in the North Atlantic.[8] Data for these spectra is not included in the program and must be provided on separate permanent files. SMOTION can be used to calculate the single amplitude ship responses. In these results the significant wave height is given in feet.

The program SMOTION has been modified to include the option of providing transfer functions from a tape. As discussed in the section on output, transfer functions can be written on tape (or a permanent file) by defining IND as 1 in the programs when the wave heading angle, β, is between 90 and 180 degrees.

SMOTION is written such that heave and pitch or sway, roll and yaw transfer functions can be provided. Heave and pitch must be provided on a device using the local file name TAPE22; sway, roll and yaw are provided on a device using the local file name TAPE23. If data is provided from both programs, the same data deck must be used for both programs. If both sets of data are not provided, the undefined data will be defined as zero. There transfer functions can be used in SMOTION to calculate absolute and relative motion transfer functions at specified locations. All length units should be given in feet.

When running the programs MOT35 and MOT246 care should be taken to define the range of the dimensional wave frequency from 0.025 to 2.0 rad/sec. Although the transfer function may be constant for some of the range, it is important to provide data at intervals of the frequency of about 0.3 in the constant region in order to assure proper evaluation in the interpolation routine.

For wave heading angles less than 90 degrees the transfer functions must be provided on computer cards. The absolute and relative motion transfer functions for locations must also be provided on computer cards. In this case values must be provided for frequencies of 0.025 to 2.0 in constant intervals of 0.025 or for specified (wave length)/(ship length) values which span the frequency range from 0.025 to 2.0.

Results can be plotted using the CALCOMP plotting routine. A listing of SMOTION is provided below. Data input descriptions are included in the program listing.

```
      PROGRAM SMOTION(INPUT=512,OUTPUT=512,TAPE7,TAPE2=512,
     X  TAPE4=512,TAPE22=512,TAPE23=512,TAPE5=INPUT,TAPE6=OUTPUT)
C         THIS PROGRAM COMPUTES SHIP RESPONSES -- SINGLE AMPLITUDE
C            (A) SIGNIFICANT VALUES,    (B) MOST PROBABLE EXTREME VALUES,
C            AND   (C) EXTREME VALUE FOR DESIGN CONSIDERATION
C         FOR ANY OF THE FOLLOWING TRANSFER FUNCTIONS
C            (1) RELATIVE BOW MOTION (RBM),    (2) HEAVE,    (3) PITCH,
C            (4) ROLL,    (5) VERTICAL SHEAR,    (6) BENDING MOMENT,
C            (7) ABSOLUTE MOTION,   OR    (8) HYDROFOIL LOADING
C         IF RBM IS INPUT, ONE OF THE FOLLOWING MAY ALSO BE COMPUTED
C            (1) WATER CONTACTS *,     (2) DECK WETNESSES,
C            (3) HULL SLAMS,    (4) HYDROFOIL BROACHINGS,
C            (5) SIGNIFICANT PRESSURES *,   OR    (6) C-S SLAMS *
C         * RELATES TO CATAMARAN CROSS-STRUCTURE
C         IF ROLL IS INPUT,  LATERAL ACCELERATIONS MAY BE COMPUTED
C         IF ABSOLUTE MOTION IS INPUT,  VERTICAL ACCELERATIONS MAY BE COMPUTED

C         WAVE SPECTRA USED ARE  (A)PIERSON-MOSKOWITZ FORMULATION AND
C            (B) 323 ACTUAL SEA SPECTRA MEASURED AT STATION INDIA

C         RESPONSE AMPLITUDES AS A FUNCTION OF SIGNIFICANT WAVE HEIGHT
C           AND PERCENTAGE EXCEEDANCE ARE TABULATED AND WRITTEN ON TAPE7
C           FOR PLOTTING ON CALCOMP 936

      COMMON /BL1/ SHIPN(6), TFT(8), YT(24), YT2(32), TCLR(16), XTIT(3),
     . PCTIT(3), BUFF(1024), XP(325), YP(325), XMIN, XMAX, XINC, XLG,
     . YMIN, YINC, ZMIN, ZINC, ISYM, TWS(3), V, L, CLR, BPL, DISPL, M
      COMMON /BL2/ SWH(323), RA(323,3), R2(323), NK,
     .              SWHPM(51), RAPM(51,3), R2PM(51)
      COMMON /BL3/ GP(36), GP2(36), YPE(36,2), ZPE(36)
      COMMON /BL4/ W(81), W2(81), WLL(81), SW(81), FR(81), RAO(81),
     . WE(81)
      COMMON /BL5/ WAVEL(50), TRAO(50), YR(50), XR(50), XW(50), TW(50)
      COMMON /BL6/ OWSPC(21), SINDIA(21), PRB(323), MI(323)
      COMMON /BL7/ GPP(36), YSUM(36,2), ZSUM(36)
      COMMON /BL8/ HA(4,30,3),HP(4,30,3),PA(4,30,3),PP(4,30,3),
     X  ROLLA(4,30,3),ROLLP(4,30,3)
      COMMON /BL9/ FN(4),OMEGAE(30),WN(30),BETA(3),WFR(4,30,3)
      COMMON /BL10/ NFN,NFR,NBTA,IFN,IBETA

      DATA PCTIT / 10HPERCENTAGE, 10H EXCEEDANC, 1HE /
      DATA XTIT / 10HSIGNIFICAN, 10HT WAVE HEI, 10HGHT IN FT. /
      DATA XMIN, XMAX, XINC, XLG / 0.0, 45.0, 5.0, 9.0/
      DATA TWS / 10HSTATION IN, 10HDIA WAVE S, 10HPECTRA     /
      DATA YT  / 10H   R.B.M. , 10HAMPLITUDE , 10HIN FEET   ,
     .           10H    HEAVE , 10HAMPLITUDE , 10HIN FEET   ,
     .           10H    PITCH , 10HAMPLITUDE , 10HIN DEGREES,
     .           10H     ROLL , 10HAMPLITUDE , 10HIN DEGREES,
     .           10HVERTICAL S, 10HHEAR AMP. , 10HIN TONS   ,
     .           10HBENDING MO, 10HMENT AMP. , 10HIN FT-TONS,
     .           10HABSOLUTE M, 10HOTION AMP., 10HIN FEET   ,
     .           10H      FOIL, 10H LOADING  , 10HIN TONS    /
```

```
      DATA YT2/
     . 10H     NUMBE, 10HR OF WATER, 10H CONTACTS , 10HPER HOUR  ,
     . 10H     NUMBE, 10HR OF DECK , 10HWETNESSES , 10HPER HOUR  ,
     . 10H         N, 10HUMBER OF H,10HULL SLAMS , 10HPER HOUR  ,
     . 10H    NUMBER, 10H OF FOIL B, 10HROACHINGS , 10HPER HOUR  ,
     . 10H         S, 10HIGNIFICANT, 10H PRESSURE , 10HIN PSI    ,
     . 10H         L, 10HATERAL ACC, 10HELERATION , 10H/ G       ,
     . 10H        VE, 10HRTICAL ACC, 10HELERATION , 10H/ G       ,
     . 10H NO. OF CR, 10HOSS-STRUCT, 10HURE SLAMS , 10HPER HOUR  /
      DATA TFT /      10H   RBM/WA , 10H  HEAVE/WA, 10H  PITCH/WA,
     . 10H   ROLL/WA ,10H  SHEAR/WA,10H    BMT/WA,10H    AM/WA  ,
     . 10HFOIL LD/WA /
      DATA TCLR /     10HWL TO CROS, 10H-STRUCTURE,
     .                10HWL TO DECK, 10H          ,
     .                10HWL TO BOTT, 10HOM OF HULL,
     .                10HWL TO FOIL, 10H          ,
     .                10H          , 10H          ,
     .                10HCG TO DECK, 10H          ,
     .                10H          , 10H          ,
     .                10HWL TO CROS, 10H-STRUCTURE /
      DATA GPP/ 500., 400., 300., 250., 200., 150., 100., 90., 80., 70.,
     1 60., 50., 40., 30., 25., 20., 18., 16., 15., 14., 13., 12., 11.,
     1 10., 9., 8., 7., 6., 5., 4., 3., 2.5, 2., 1.5, 1.0, 0.5 /

C       OWSPC -- AREA 2 OCEAN WAVE STATISTICS FROM "HOGBEN + LUMB" IN PERCENT
      DATA OWSPC / 3.34580, 5.94340, 15.04857, 18.75943, 14.38183,
     1 12.34236, 8.42032, 6.78815, 4.41381, 4.40777, .73915, .80553,
     2 1.19773, 1.02576, .47366, .48573, .50685, .40729, .48573,
     2 .01508, .00603 /
C       INDIA -- NUMBER OF INDIA SPECTRA IN EACH O.W.S. GROUP
      DATA SINDIA / 86., 24., 21., 26., 27., 15., 16., 22., 14., 8., 8.,
     1 8., 8., 4., 6., 10., 5., 2., 2., 8., 3. /
      DATA MI / 86*1, 24*2, 21*3, 26*4, 27*5, 15*6, 16*7, 22*8, 14*9,
     1 8*10, 8*11, 8*12, 8*13, 4*14, 6*15, 10*16, 5*17, 2*18, 2*19,
     2 8*20, 3*21 /

      G = 32.174
      TPIG = 6.283185 * G
      A = 0.0081 * G * G
      RAD = 0.0174533
      RHO2 = 0.5 * 1.9905
C
C       W(I) -- WAVE FREQUENCY (RAD/SEC), INCREMENTS OF 0.05 FROM 0 TO 2.0
      NW = 81
      W(1) = 0.0
      W2(1) = 0.0
      DO 2 I=2,NW
      W(I) = W(I-1) + 0.025
      W2(I) = W(I) * W(I)
    2 CONTINUE
      CALL PLOTS (BUFF, 1024, 7)
      READ(5,502) ITHPM,ITSRYM,ICHECK
C  IF ITHPM = ITSRYM = 0 TRANSFER FUNCTION DATA IS ON COMPUTER CARDS
```

```
C   IF ITHPM = ITSRYM = 1 TRANSFER FUNCTION DATA IS ON TAPES 22 AND 23
C   IT ITHPM = 1 AND ITSRYM = 0 HEAVE AND PITCH T.F. DATA
C   IS ON TAPE 22.  ROLL = 0.
C   IF ITHPM = 0 AND ITSRYM = 1 ROLL T.F. DATA IS ON TAPE 23
C   AND HEAVE = PITCH = 0.

C   DEFINE ICHECK AS 0. UNLESS ITHPM = ITSRYM = 1
C
C   IF ICHECK = 0 READ DATA -- DO NOT CHECK.
C   IF ICHECK = 1 CHECK DATA AND RUN PROGRAM.
C   IF ICHECK = 2 CHECK HPM AND SRYM DATA FOR COMPATIBILITY.
C
      ITAPE=ITHPM+ITSRYM
      IF(ITAPE.EQ.0) GO TO 11
      YT(1)=10HRELATIVE M
      YT(2)=10HOTION AMP.
      TFT(1) =10H    RM/WA
      READ(5,501) XLND

C   XLND = LENGTH IN FEET USED IN HPM AND SRYM.
C
      CALL DATAIN(XLND,ITHPM,ITSRYM,ICHECK)
      IF(ICHECK.EQ.777) GO TO 777
   11 READ(5,502) NSHIPS

C         NSHIPS -- NUMBER OF SHIPS INPUT
C
      DO 200 NSH=1,NSHIPS
      REWIND 2
      REWIND 4

      READ (5,500) (SHIPN(I), I=1,6)
C        SHIPN -- TITLE SUCH AS SHIP NAME, ETC. (UP TO 60 CHARACTERS)

      READ (5,502) L, INO, NWL, M, IP
C        L  --  1 FOR RELATIVE BOW MOTION,  2 FOR HEAVE,  3 FOR PITCH,
C               4 FOR ROLL,  5 FOR VERTICAL SHEAR,  6 FOR BENDING MOMENT,
C               7 FOR ABSOLUTE MOTION,  8 FOR FOIL LOAD
C        M  -- 1 FOR CROSS-STRUCTURE WATER CONTACTS,  2 FOR DECK WETNESSES,
C              3 FOR HULL SLAMS,  4 FOR FOIL BROACHINGS,
C              5 FOR CROSS-STRUCTURE SIGNIFICANT PRESSURES,
C              6 FOR LATERAL ACCELERATIONS,
C              7 FOR VERTICAL ACCELERATIONS,
C              8 FOR CROSS-STRUCTURE SLAMS
C        IP  --  1 PLOTS ONLY SIGNIFICANT VALUES OF THE RESPONSE (L)
C                2 PLOTS SIGNIFICANT AND MOST PROBABLE EXTREME VALUES
C                3 PLOTS ONLY EXTREME VALUES FOR DESIGN CONSIDERATION
C                4 PLOTS ONLY ADDITIONAL RESPONSE SPECIFIED BY (M)
C                5 PLOTS ALL CALCULATED RESPONSES SPECIFIED BY (L) AND (M)
C                6 PLOTS SIGNIFICANT VALUES FOR (L) AND (M)
C                EXCEEDANCE PLOTS ARE MADE IN ALL CASES
C                0 OMITS ALL PLOTS
C        INO  -- 1 IF TRANSFER FUNCTION INPUT DIRECTLY FOR W(I),I=2,41
C        INO  -- 2 IF T.F. INPUT AS FUNCTION OF (WAVE LENGTH / SHIP LENGTH)
```

```
C        INO  -- 3 IF T.F. INPUT FOR EVEN INCREMENTS OF NON-DIM.ENC.FREQ.
C        NWL  -- NO. OF WAVE LENGTHS INPUT IF INO=2   (40 IS MAX.)

      READ(5,508) BPL,DISPL,V,CLR,ALPHA,XKK,RDOT,TBETA,XX,YY
C        BPL  -- SHIP LENGTH IN FEET
C        DISPL -- DISPLACEMENT IN TONS  (BOTH HULLS OF CATAMARAN)
C        V     -- SHIP SPEED IN KNOTS
C        CLR   -- VERTICAL DISTANCES IN FEET FOR CALC. IF M=1,2,3,4,6,8
C                  IF M=1,  CLR = WL TO CROSS-STRUCTURE
C                  IF M=2,  CLR = WL TO DECK
C                  IF M=3,  CLR = WL TO BOTTOM OF HULL
C                  IF M=4,  CLR = WL TO TOP OF FOIL
C                  IF M=6,  CLR = CG TO DECK
C                  IF M=8,  CLR = WL TO CROSS-STRUCTURE
C                  IF M=5 OR M=7, CLR IS NOT USED
C        ALPHA -- CONSTANT FOR EXTREME VALUE CALCULATION
C                 USE ALPHA = 0.01 FOR 99 PERCENT ASSURANCE
C        XKK  -- CONSTANT (K) FOR CALC. OF SIGN.PRESSURE ON CROSS-STRUCTURE
C        RDOT -- THRESHOLD VELOCITY IN FT/SEC FOR SLAM CALCULATIONS
C  TBETA -- HEADING IN DEGREES (180 = HEAD SEAS)
C  USE XX AND YY WHEN ITHPM OR ITSRYM IS NOT ZERO.
C  XX AND YY ARE COORDINATES FOR CALCULATION OF
C ABSOLUTE AND RELATIVE MOTION.
C  XX -- DIST. FROM CG ALONG CL (+ FORWARD)
C  YY -- DIST. FROM CG PERPENDICULAR TO CL (+ PORT SIDE)

      IF (RDOT .LE. 0.0) RDOT = 12.0 * SQRT(BPL/520.)

      SRLG = 1.0 / SQRT(BPL/G)
      VG = V * 1.6878 / G
      VG2 = 2.0 * VG
      VG4 = 4.0 * VG
      CLRSQ = CLR * * 2
      L1 = L * 3 - 2
      L2 = L1 + 1
      L3 = L2 + 1
      M1 = M * 4 - 3
      M2 = M1 + 1
      M3 = M2 + 1
      M4 = M3 + 1
      IF (M .GT. 0) GO TO 4
      MA = 12
      MB = 12
      GO TO 3
    4 MA = M * 2 - 1
      MB = MA + 1
    3 CONTINUE

      READ(5,506) YMIN,YINC,ZMIN,ZINC,ISYM
C        YMIN, YINC  --  SCALING FACTORS FOR PLOTS OF RESPONSES (L)
C          YMIN IS MINIMUM VALUE FOR RESPONSE AMPLITUDE AXIS (GENERALLY 0.0)
C          YINC IS INCREMENT OF RESPONSE AMP. FOR 1.0 INCH ON AXIS
C        ZMIN, ZINC -- SCALING FACTORS FOR PLOTS OF RESPONSES (M)
C          IF NOT INPUT, PROGRAM WILL ESTABLISH A SUITABLE SCALE
```

```
C          TOTAL LENGTH OF AXIS IS 8.  INCHES
C        ISYM  -- CONTROL FOR TYPE OF SYMBOL ON PLOTS (ISYM=3 FOR +)
C          IF ISYM=0 IS DESIRED, 0 MUST BE TYPED ON THE CARD

      RAO(1) = 0.0
      GO TO (6, 8, 208), INO

    6 READ (5,504) (RAO(I), I=2,81)
C        RAO(I) -- VALUE OF INPUT FUNCTION AT FREQUENCY W(I)
C                    IF L=1  (R.B.M.AMPLITUDE)/(WAVE AMPLITUDE)     IS INPUT
C                    IF L=2  (HEAVE AMPLITUDE)/(WAVE AMPLITUDE)     IS INPUT
C                    IF L=3  (PITCH AMPLITUDE)/(WAVE SLOPE)         IS INPUT
C                    IF L=4  ( ROLL AMPLITUDE)/(WAVE SLOPE)         IS INPUT
C                    IF L=5  (VERT.SHEAR AMP.)/(WAVE AMP.*DISPL/L)  IS INPUT
C                    IF L=6  (BEND.MOMENT AMP.)/(WAVE AMP.*DISPL)   IS INPUT
C                    IF L=7  (ABSOLUTE MOTION AMP.)/(WAVE AMP.)     IS INPUT
C                    IF L=8  (FOIL LOADING)/(WAVE AMP.*DISPL/L)     IS INPUT
      GO TO 19

    8 READ (5,504) (WAVEL(N), N=1,NWL)
C        WAVEL -- VALUES OF (WAVE LENGTH / SHIP LENGTH)
C                   CAN BE IN EITHER ASCENDING OR DESCENDING ORDER
      READ (5,504) (TRAO (N), N=1,NWL)
C        TRAO -- VALUES OF TRANSFER FUNCTION CORRESPONDING TO WAVEL
      IF (WAVEL(2).GT.WAVEL(1)) GO TO 9
      DO 5 N=1,NWL
      NN = NWL + 1 - N
      XR(NN) = WAVEL(N)
    5 YR(NN) = TRAO(N)
      DO 7 N=1,NWL
      WAVEL(N) = XR(N)
    7 TRAO(N)  = YR(N)
    9 DO 10 N=1,NWL
   10 WAVEL(N) = WAVEL(N) * BPL
      DO 18 I=2,NW
      WLI = TPIG / W2(I)
      IF (WLI .GE. WAVEL(1) .AND. WLI .LE. WAVEL(NWL)) GO TO 17
      GO TO (12, 14, 14, 14, 16, 16, 14, 16), L
   12 IF (WLI .LT. WAVEL(1))  RAO(I) = 1.0
      IF (WLI .GT. WAVEL(NWL)) RAO(I) = 0.0
      GO TO 18
   14 IF (WLI .LT. WAVEL(1))  RAO(I) = 0.0
      IF (WLI .GT. WAVEL(NWL)) RAO(I) = 1.0
      GO TO 18
   16 RAO(I) = 0.0
      GO TO 18
   17 RAO(I) = YINTP(WLI, WAVEL, TRAO, NWL)
   18 CONTINUE
      GO TO 19

  208 IF(ITAPE.EQ.0) GO TO 331
      NTW=NFR
      TFN=V*1.688/SQRT(32.174*XLND)
      DO 310 I=1,NFN
```

```
      IFN=I
      XI=FN(I)
      IF(1.01*XI.GE.TFN .AND. .99*XI.LE.TFN) GO TO 311
  310 CONTINUE
      WRITE(6,314) TFN
      GO TO 777
  311 DO 312 I=1,NBTA
      IBETA=I
      XI=BETA(I)
      IF(1.01*XI.GE.TBETA .AND. .99*XI.LE.TBETA) GO TO 313
  312 CONTINUE
      WRITE(6,315) TBETA
      GO TO 777
C   TRAO -- VALUES OF TRANSFER FUNCTION FOR FREQUENCIES.
  313 DO 210 I=1,NTW
      XW(I)=OMEGAE(I)
      DUM=WFR(IFN,I,IBETA)
      TW(I)=DUM
  210 WN(I)=DUM*DUM/32.174
      GO TO(301,302,303,304,305,305,307,305),L
  301 CALL RELABS(1,XX,YY)
      GO TO 330
  302 DO 322 I=1,NTW
  322 TRAO(I)=HA(IFN,I,IBETA)
      GO TO 330
  303 DO 323 I=1,NTW
  323 TRAO(I)=PA(IFN,I,IBETA)
      GO TO 330
  304 DO 324 I=1,NTW
  324 TRAO(I)=ROLLA(IFN,I,IBETA)
      GO TO 330
  305 WRITE(6,316)
  316 FORMAT(5X,*DATA NOT AVAILABLE*)
      GO TO 777
  307 CALL RELABS(2,XX,YY)
      GO TO 330
  331 READ(5,508) TWMIN,TWMAX,TWINC
C   TWMIN, TWMAX, TWINC ARE INCREMENTS OF NON-DIM. ENC. FREQ.
      NTW=(TWMAX-TWMIN)/TWINC+1.1
      READ(5,508) (TRAO(I),I=1,NTW)
C      TRAO -- VALUES OF TRANSFER FUNCTION FOR FREQ. FROM TWMIN TO TWMAX
      XW(1) = TWMIN
      DO 213 I=2,NTW
  213 XW(I)=XW(I-1) +TWINC
      DO 211 I=1,NTW
      TW(I) = XW(I) * SRLG
      IF (V .EQ. 0.0) GO TO 211
      TW(I) = (-1.0 + SQRT(1.0 + VG4*TW(I))) / VG2
  211 CONTINUE
  330 CONTINUE
      DO 218 I=1,NW
      IF (W(I).GE.TW(1) .AND. W(I).LE.TW(NTW)) GO TO 217
      GO TO (212,214,214,214,216,216,214,216), L
  212 IF (W(I) .LT. TW(1)  ) RAO(I) = 0.0
```

```
      IF (W(I) .GT. TW(NTW)) RAO(I) = 1.0
      GO TO 218
  214 IF (W(I) .LT. TW(1)   ) RAO(I) = 1.0
      IF (W(I) .GT. TW(NTW)) RAO(I) = 0.0
      GO TO 218
  216 RAO(I) = 0.0
      GO TO 218
  217 RAO(I) = YINTP (W(I), TW, TRAO, NTW)
  218 CONTINUE

   19 CONTINUE
      WRITE(6,600) (SHIPN(I),I=1,6), BPL, DISPL, V, TCLR(MA), TCLR(MB),
     . CLR, ALPHA
      WRITE (6,604) TFT(L)
      WRITE (6,603) W(1), RAO(1)
      VGC=VG*COS(TBETA*RAD)
      DO 30 I=2,NW
      WE(I)=W(I)-VGC*W2(I)
      GO TO (28, 28, 22, 22, 24, 26, 28, 24), L
   22 WL = TPIG / W2(I)
      RAO(I) = RAO(I) * 360. / WL
      GO TO 28
   24 RAO(I) = RAO(I) * DISPL / BPL
      GO TO 28
   26 RAO(I) = RAO(I) * DISPL
   28 WLL(I) = TPIG / W2(I) / BPL
      WRITE(6,606) WLL(I), WE(I), W(I), RAO(I)
      RAO(I) = RAO(I) * * 2
   30 CONTINUE
      WRITE(6,607)

C        CALCULATION OF RESPONSE AMPLITUDES WITH 323 ACTUAL SEA SPECTRA
      NK = 323
      SW(1) = 0.0
      SUMPRB = 0.0
      EXTREME = -0.0
      DO 50 K=1,NK
      READ (2) NREC, SWH(K), (SW(I),I=2,NW)
      MIK = MI(K)
      PRB(K) = OWSPC(MIK) / SINDIA(MIK)
      IF (K.EQ.1 .OR. K.EQ.51 .OR. K.EQ.101 .OR. K.EQ.151 .OR. K.EQ.201
     1 .OR. K.EQ.251 .OR. K.EQ.299) GO TO 34
      GO TO 36
   34 WRITE(6,600) (SHIPN(I),I=1,6), BPL, DISPL, V, TCLR(MA), TCLR(MB),
     . CLR, ALPHA
      IF (M .EQ. 0) WRITE (6,608) YT(L1), YT(L2), YT(L3),
     . TCLR(4), TCLR(4), TCLR(4), TCLR(4)
      IF (M .GT. 0) WRITE (6,608) YT(L1), YT(L2), YT(L3), YT2(M1),
     . YT2(M2), YT2(M3), YT2(M4)
   36 DO 40 I=1,NW
   40 FR(I) = RAO(I) * SW(I)
      EO = SIMPUN (W, FR, NW)
      DO 42 I=2,NW
   42 FR(I) = FR(I) * WE(I) * WE(I)
```

```
      EV = SIMPUN (W, FR, NW)
      DO 47 I=2,NW
   47 FR(I) = FR(I) * WE(I) * WE(I)
      EA = SIMPUN (W, FR, NW)
      WW = SQRT(EV/ED)
      EVED = 572.9578 * WW
      SQRTED = SQRT(ED)
      RA(K,1) = 2.0 * SQRTED
      DTIME = 68.0 - 1.4 * SWH(K)
      EVEDT = EVED * DTIME
      FRA2 = 2.0 * ALOG(EVEDT)
      RA(K,2) = SQRT(FRA2) * SQRTED
      IF (ALPHA. GT. 0.0) GO TO 41
      RA(K,3) = -0.0
      GO TO 44
   41 FRA3 = 2.0 * ALOG (EVEDT/ ALPHA)
      RA(K,3) = SQRT(FRA3) * SQRTED
      IF (RA(K,3) .GT. EXTREME) EXTREME = RA(K,3)
   44 CONTINUE
      IF (M .GT. 0) GO TO 46
      WRITE (6,610) NREC, SWH(K), (RA(K,J), J=1,3)
      GO TO 48
   46 GO TO (51, 51, 53, 51, 54, 56, 57, 53), M
   51 ECST = CLRSQ  / (2.0*ED)
      IF (ECST .GT. 600.0) GO TO 59
      R2(K) = EVED * EXP(-ECST)
      GO TO 58
   53 ECST = CLR * * 2 / (2.0 * ED) + RDOT * * 2 / (2.0 * EV)
      IF (ECST .GT. 600.0) GO TO 59
      R2(K) = EVED * EXP(-ECST)
      GO TO 58
   54 R2  (K) = XKK * 4.2 * EV
      GO TO 58
   56 R2  (K) = 2.0 * SQRT(EA) * RAD * CLR / G
      GO TO 58
   57 R2  (K) = 2.0 * SQRT(EA) / G
      GO TO 58
   59 R2(K) = 0.0
   58 WRITE (6,610) NREC, SWH(K), (RA(K,J), J=1,3), R2(K)
   48 SUMPRB = SUMPRB + PRB(K)
   50 CONTINUE
      WRITE (6,611) EXTREME
C        CALCULATION OF RESPONSE AMPLITUDES WITH PIERSON-MOSKOWITZ SPECTRA
      SWHPM(1) = 0.0
      R2PM(1) = 0.0
      RAPM(1,1) = 0.0
      RAPM(1,2) = 0.0
      RAPM(1,3) = 0.0
      WRITE(6,600) (SHIPN(I),I=1,6), BPL, DISPL, V, TCLR(MA), TCLR(MB),
     . CLR, ALPHA
      IF (M .EQ. 0) WRITE (6,608) YT(L1), YT(L2), YT(L3),
     . TCLR(4), TCLR(4), TCLR(4), TCLR(4)
      IF (M .GT. 0) WRITE (6,608) YT(L1), YT(L2), YT(L3), YT2(M1),
```

```
      . YT2(M2), YT2(M3), YT2(M4)
      WRITE(6,618)
      DO 70 K=2,46
      READ (4) SWHPM(K), (SW(I),I=2,NW)
      DO 60 I=1,NW
   60 FR(I) = RAO(I) * SW(I)
      ED = SIMPUN (W, FR, NW)
      IF (ED.GT.0) GO TO 63
      RAPM(K,1) = 0.0
      RAPM(K,2) = 0.0
      RAPM(K,3) = 0.0
      R2PM(K) = 0.0
      GO TO 65
   63 SQRTED = SQRT(ED)
      DO 62 I=2,NW
   62 FR(I) = FR(I) * WE(I) * WE(I)
      EV = SIMPUN (W, FR, NW)
      DO 67 I=2,NW
   67 FR(I) = FR(I) * WE(I) * WE(I)
      EA = SIMPUN (W, FR, NW)
      WW = SQRT(EV/ED)
      EVED = 572.9578 * WW
      RAPM(K,1) = 2.0 * SQRTED
      DTIME = 68.0 - 1.4 * SWHPM(K)
      EVEDT = EVED * DTIME
      FRA2 = 2.0 * ALOG(EVEDT)
      RAPM(K,2) = SQRT(FRA2) * SQRTED
      IF (ALPHA. GT. 0.0) GO TO 61
      RAPM(K,3) = -0.0
      GO TO 64
   61 FRA3 = 2.0 * ALOG(EVEDT / ALPHA)
      RAPM(K,3) = SQRT(FRA3) * SQRTED
   64 CONTINUE
      IF (M .GT. 0) GO TO 66
   65 WRITE(6,610) K, SWHPM(K), (RAPM(K,J), J=1,3)
      GO TO 68
   66 GO TO (71, 71, 73, 71, 74, 76, 77, 73), M
   71 ECST = CLRSQ  / (2.0*ED)
      IF (ECST .GT. 600.0) GO TO 79
      R2PM(K) = EVED * EXP(-ECST)
      GO TO 78
   73 ECST = CLR * * 2 / (2.0 * ED) + RDOT * * 2 / (2.0 * EV)
      IF (ECST .GT. 600.0) GO TO 79
      R2PM(K) = EVED * EXP(-ECST)
      GO TO 78
   74 R2PM(K) = XKK * 4.2 * EV
      GO TO 78
   76 R2PM(K) = 2.0 * SQRT(EA) * RAD * CLR / G
      GO TO 78
   77 R2PM(K) = 2.0 * SQRT(EA) / G
      GO TO 78
   79 R2PM(K) = 0.0
   78 WRITE (6,610) K, SWHPM(K), (RAPM(K,J), J=1,3), R2PM(K)
   68 CONTINUE
   70 CONTINUE
```

```
C       PROBABILITY COMPUTATIONS
      WRITE(6,600) (SHIPN(I),I=1,6), BPL, DISPL, V, TCLR(MA), TCLR(MB),
     . CLR, ALPHA
      NPC = 36
      GPM = 1.0
      IF (L .EQ. 5) GPM = 10.0
      IF (L .EQ. 6) GPM = 1000.0
      GPM2 = 1.0
      IF (M .EQ. 6) GPM2 = 0.01
      IF (M.EQ.7) GPM2 = 0.01
      DO 80 I=1,NPC
      GP2(I) = GPP(I) * GPM2
   80 GP(I) = GPP(I) * GPM
      WRITE (6,646)
      WRITE (6,628) YT(L1), YT(L2), YT2(M1), YT2(M2), YT2(M3)
      DO 92 I=1,NPC
      ZSUM(I) = 0.0
      ZPE(I) = 0.0
      DO 92 J=1,2
      YSUM(I,J) = 0.0
      YPE (I,J) = 0.0
   92 CONTINUE
      DO 100 J=1,2
      DO 100 K=1,323
      DO 94 I=1,NPC
      IF (RA  (K,J) .LE. GP(I)) GO TO 94
      YSUM(I,J) = YSUM(I,J) + PRB(K)
      GO TO 95
   94 CONTINUE
   95 IF (J .EQ. 2) GO TO 100
      IF (M .EQ. 0) GO TO 100
      DO 96 I=1,NPC
      IF (R2(K) .LE. GP2(I)) GO TO 96
      ZSUM(I) = ZSUM(I) + PRB(K)
      GO TO 100
   96 CONTINUE
  100 CONTINUE
      DO 110 I=1,NPC
      II = I-1
      IF (I.EQ.1) II=I
      DO 102 J=1,2
  102 YPE(I,J) = YPE(II,J) + YSUM(I,J)
      IF (M .GT. 0) GO TO 105
      WRITE (6,630) GP(I), (YPE(I,J), J=1,2)
      GO TO 110
  105 ZPE(I) = ZPE(II) + ZSUM(I)
      WRITE(6,630) GP(I), (YPE(I,J),J=1,2), GP2(I), ZPE(I)
  110 CONTINUE
      IF (IP .EQ. 0) GO TO 200

C       PLOTS OF PERCENTAGE EXCEEDANCE DIAGRAMS
      GO TO(112,112,115,114,112,112),IP
  112 CALL PLOTPR (1, GPM)
      IF (M .EQ. 0) GO TO 115
```

```
114 CALL PLOTPR (2,GPM2)
115 CONTINUE
C      PLOTS OF RESPONSES VS. SIGNIFICANT WAVE HT.
    GO TO (122,122,124,126,122,122),IP
122 CALL PLOTRS (1,1)
    IF (IP .EQ. 1) GO TO 200
    IF(IP.EQ.6) GO TO 126
    CALL PLOTRS (1,2)
    IF (IP .EQ. 2) GO TO 200
124 CALL PLOTRS (1,3)
    IF (IP .EQ. 3) GO TO 200
    IF (M .EQ. 0) GO TO 200
126 CALL PLOTRS (2,1)

200 CONTINUE
    CALL PLOT (0.0, 0.0, -3)
    CALL PLOT (0.0, 0.0, 999)
314 FORMAT(10X,*TFN = *,E12.5, *NOT FOUND*)
315 FORMAT(10X,*TBETA = *,E12.5, *NOT FOUND*)
500 FORMAT (6A10)
501 FORMAT (9F8.2)
502 FORMAT (10I3)
504 FORMAT (10F6.2)
506 FORMAT (4F6.3, I6)
508 FORMAT (10F8.3)
600 FORMAT (1H1, 10X, 6A10 // 17H    SHIP LENGTH =, F6.1, 3H FT, 5X,
   . 14HDISPLACEMENT =, F7.1, 5H TONS, 5X, 7HSPEED =, F5.1, 6H KNOTS,
   . 5X, 2A10, 2H =, F5.1, 3H FT, 5X,
   . 7HALPHA =, F5.2 / 3X, 129(1H*) )
603 FORMAT (24X, 2F12.3)
604 FORMAT (70H0  TRANSFER FUNCTION INTERPOLATED AT .025 INCREMENTS OF
   . WAVE FREQUENCY // 17X, 22HENC.FREQ.   WAVE FREQ. /
   . 38H        WL/L        (RAD/SEC)    (RAD/SEC) , A10 )
606 FORMAT (4F12.3)
607 FORMAT (19H0  WL = WAVE LENGTH, 8X, 15HL = SHIP LENGTH, 8X,
   1 25HWA = WAVE AMPLITUDE (FT)  / 33H   RBM = RELATIVE BOW MOTION (F
   2T),  5X, 28HHEAVE = HEAVE AMPLITUDE (FT),  5X, 29HPITCH = PITCH AM
   3PLITUDE (DEG), 5X, 27HROLL = ROLL AMPLITUDE (DEG)         /
   4 36H   VSH = VERTICAL SHEAR FORCE (TONS),
   1                    5X, 30HBMT = BENDING MOMENT (FT-TONS)  /
   2 32H   ABM = ABSOLUTE MOTION  (FT)             , 5X,
   . 26HFOIL LD = FOIL LOAD (TONS) )
608 FORMAT (1H0, 33X, 3A10 / 28X, 42(1H-) /  69H       WAVE       SIGNIFIC
   .ANT   SIGNIFICANT  MOST PROBABLE  EXTREME VALUE,7X,
   .  4A10             / 72 H      SPECTRA  WAVE HT. (FT)       VALUE       EXT
   .REME VALUE  FOR DESIGN USE   ,  4X, 40(1H-) )
610 FORMAT (I9, F13.2, 3F14.2, F32.2)
611 FORMAT (1H0, 43X, 10HEXTREME = , F10.2)
618 FORMAT (18H0PIERSON-MOSKOWITZ)
628 FORMAT (1H0, 2A10, 26H  PERCENTAGE EXCEEDANCE    , 3A10 / 23X,
   . 21HSIGN.  MOST PROB.EXT., 28X, 8HP.C.EXC. )
630 FORMAT (F16.1, F12.2, F10.2, 14X, F14.1, F12.2)
646 FORMAT (75H0PROBABILITY BASED ON OCEAN WAVE STATISTICS FROM AREA 2
   . - HOGBEN + LUMB            )
777 CONTINUE
    END
```

```
      SUBROUTINE RELABS(ITAB,X,Y)
C   ITAB = 1 TO COMPUTE RELATIVE MOTION
C   ITAB = 2 TO COMPUTE ABSOLUTE MOTION
      COMMON /BL5/ WAVEL(50),TRAO(50),YR(50),XR(50),XW(50),TW(50)
      COMMON /BL8/ HA(4,30,3),HP(4,30,3),PA(4,30,3),PP(4,30,3),
     X  RA(4,30,3),RP(4,30,3)
      COMMON /BL9/ FN(4),WE(30),WN(30),BETA(3),WFR(4,30,3)
      COMMON /BL10/ NFN,NFR,NBTA,IFN,IBETA
      DIMENSION PRAO(30)
      COMPLEX ZA,II
      RAD=.0174533
      II=CMPLX(0.,1.)
      BET=BETA(IBETA)*RAD
      XY=X*COS(BET)-Y*SIN(BET)
      DO 10 N=1,NFR
      HEAVE=HA(IFN,N,IBETA)
      PITCH=WN(N)*PA(IFN,N,IBETA)
      ROLL=WN(N)*RA(IFN,N,IBETA)
      HEAVEP=RAD*HP(IFN,N,IBETA)
      PITCHP=RAD*PP(IFN,N,IBETA)
      ROLLP=RAD*RP(IFN,N,IBETA)
      ZA=HEAVE*CEXP(-II*HEAVEP)+Y*ROLL*CEXP(-II*ROLLP)
     X  -X*PITCH*CEXP(-II*PITCHP)
      IF(ITAB.EQ.1) ZA=ZA-CEXP(II*WN(N)*XY)
      TRAO(N)=CABS(ZA)
      PRAO(N)=ATAN2(-AIMAG(ZA),REAL(ZA))
   10 CONTINUE
      IF(ITAB.EQ.1) WRITE(6,100) FN(IFN),BETA(IBETA),X,Y
      IF(ITAB.EQ.2) WRITE(6,200) FN(IFN),BETA(IBETA),X,Y
      WRITE(6,300) (WE(N),TRAO(N),PRAO(N),N=1,NFR)
  100 FORMAT(///10X,*RELATIVE MOTION AND PHASE*//10X,*FN = *,F8.2/
     X  10X,*BETA = *,F8.2/10X,*X = *,F8.2/10X,*Y = *,F8.2/)
  200 FORMAT(///10X,*ABSOLUTE MOTION AND PHASE*//10X,*FN = *,F8.2/
     X  10X,*BETA = *,F8.2/10X,*X = *,F8.2/10X,*Y = *,F8.2/)
  300 FORMAT(12X,*WE*,9X,*AMPLITUDE*,10X,*PHASE*/(10X,F7.3,2(5X,E12.5)))
      RETURN
      END
*DECK DATN
      SUBROUTINE DATAIN(XLND,ITHPM,ITSRYM,ICHECK)
      COMMON /BL8/ HA(4,30,3),HP(4,30,3),PA(4,30,3),PP(4,30,3),
     X  RA(4,30,3),RP(4,30,3)
      COMMON /BL9/ FN(4),WE(30),WN(30),BETA(3),WFR(4,30,3)
      COMMON /BL10/ NFN,NFR,NBTA,IFN,IBETA
      DIMENSION BFN(4),BWE(30),BBETA(3)
      SQRTGL=SQRT(32.174/XLND)
      IF(ITHPM+ITSRYM.EQ.2) GO TO 15
      IF(ITHPM.EQ.0) GO TO 25
      READ(22) NFN,NFR,NBTA
      READ(22) (FN(I),I=1,NFN),(WE(I),I=1,NFR),(BETA(I),I=1,NBTA)
      READ(22) (((WFR(JJ,N,MM),HA(JJ,N,MM),HP(JJ,N,MM),PA(JJ,N,MM),
     X  PP(JJ,N,MM),JJ=1,NFN),N=1,NFR),MM=1,NBTA)
      DO 35 N=1,NFR
      WE(N)=WE(N)*SQRTGL
```

```
      DO 35 JJ=1,NFN
      DO 35 MM=1,NBTA
      WFR(JJ,N,MM)=WFR(JJ,N,MM)*SQRTGL
      RA(JJ,N,MM)=0.
   35 RP(JJ,N,MM)=0.
      RETURN
   25 READ(23) NFN,NFR,NBTA
      READ(23)  (FN(I),I=1,NFN),(WE(I),I=1,NFR),(BETA(I),I=1,NBTA)
      READ(23)  (((WFR(JJ,N,MM),DUM,DUM,RA(JJ,N,MM),RP(JJ,N,MM),DUM,DUM,
     X   JJ=1,NFN),N=1,NFR),MM=1,NBTA)
      DO 45 N=1,NFR
      WE(N)=WE(N)*SQRTGL
      DO 45 JJ=1,NFN
      DO 45 MM=1,NBTA
      WFR(JJ,N,MM)=WFR(JJ,N,MM)*SQRTGL
      HA(JJ,N,MM)=0.
      HP(JJ,N,MM)=0.
      PA(JJ,N,MM)=0.
   45 PP(JJ,N,MM)=0.
      RETURN
   15 READ(22) NFN,NFR,NBTA
C     IF(NFN.EQ.777) GO TO 777
C  NOTE -- NEED TO ACCOMMODATE DATA FOR 0.LE.BETA.LT.90.
C  DATA RECORD BEFORE EOF IS 777,777,777.
      READ(23)MFN,MFR,MBTA
      IF(NFN.EQ.MFN.AND.NFR.EQ.MFR.AND.NBTA.EQ.MBTA) GO TO 10
      WRITE(6,100) NFN,NFR,NBTA,MFN,MFR,MBTA
      ICHECK=777
      RETURN
   10 READ(22)  (FN(I),I=1,NFN),(WE(I),I=1,NFR),(BETA(I),I=1,NBTA)
      READ(23)  (BFN(I),I=1,NFN),(BWE(I),I=1,NFR),(BBETA(I),I=1,NBTA)
      IF(ICHECK.EQ.0) GO TO 60
      DO 20 I=1,NFN
      BI=BFN(I)
      XI=FN(I)
      IF(1.01*XI.LT.BI .OR. .99*XI.GT.BI) GO TO 50
   20 CONTINUE
      DO 30 I=1,NFR
      BI=BWE(I)
      XI=WE(I)
      IF(1.01*XI.LT.BI .OR. .99*XI.GT.BI) GO TO 50
   30 CONTINUE
      DO 40 I=1,NBTA
      BI=BBETA(I)
      XI=BETA(I)
      IF(1.01*XI.LT.BI .OR. .99*XI.GT.BI) GO TO 50
   40 CONTINUE
      WRITE(6,101)
      IF(ICHECK.EQ.1) GO TO 60
      ICHECK=777
      RETURN
   50 WRITE(6,200)
      WRITE(6,201)  (FN(I),I=1,NFN)
      WRITE(6,201)  (WE(I),I=1,NFR)
```

```
      WRITE(6,201) (BETA(I),I=1,NBTA)
      WRITE(6,202)
      WRITE(6,201) (BFN(I),I=1,NFN)
      WRITE(6,201) (BWE(I),I=1,NFR)
      WRITE(6,201) (BBETA(I),I=1,NBTA)
      ICHECK=777
      RETURN
   60 READ(22)(((DUM,HA(JJ,N,MM),HP(JJ,N,MM),PA(JJ,N,MM),PP(JJ,N,MM),
     X  JJ=1,NFN),N=1,NFR),MM=1,NBTA)
      READ(23) (((WFR(JJ,N,MM),DUM,DUM,RA(JJ,N,MM),RP(JJ,N,MM),DUM,
     X  DUM,JJ=1,NFN),N=1,NFR),MM=1,NBTA)
C  WFR, SWAY AMPLITUDE , SWAY PHASE, YAW AMPLITUDE AND YAW PHASE ARE
C  LOCATED IN THE *DUM* LOCATIONS.
C  THEY ARE NOT USED AT PRESENT AND THEREFORE ARE NOT DIMENSIONED ETC.
      DO 55 N=1,NFR
      WE(N)=WE(N)*SQRTGL
      DO 55 JJ=1,NFN
      DO 55 MM=1,NBTA
   55 WFR(JJ,N,MM)=WFR(JJ,N,MM)*SQRTGL
  100 FORMAT(1H1,9X,*DATA SETS DO NOT MATCH*/ 10X, *FOR HPM    NFN = *,
     X  I3,*,  NFR = *,I3,*,  NBTA = *,I3/10X,*FOR SRYM  NFN = *,I3,
     X  *,  NFR = *,I3,*,  NBTA = *,I3)
  101 FORMAT(///10X,*DATA FROM TAPES IS COMPATIBLE*)
  200 FORMAT(1H1,9X,*HPM - FN, WE, BETA*/)
  201 FORMAT (10X,10F10.5)
  202 FORMAT(///9X,*SRYM - FN, WE, BETA*/)
      RETURN
      END
*DECK YINT
      FUNCTION YINTP(XA,X,Y,N)
      DIMENSION X(1), Y(1)
    1 DO 10 I=1,N
       IF (X(I)-XA) 10,10,2
    2 IN=I-2
      IF(IN) 4,4,6
    4 IN=1
      GO TO 12
    6 NN=N-3
      IF(IN-NN) 12,12,8
    8 IN=NN
      GO TO 12
   10 CONTINUE
   12 IO=IN+3
      YINTP=0.
      DO 20 I=IN,IO
      PROD=Y(I)
      DO 16 J=IN,IO
      IF(I-J) 15,16,15
   15 PROD=PROD*(XA-X(J))/(X(I)-X(J))
   16 CONTINUE
   20 YINTP=YINTP+PROD
   21 RETURN
      END
```

```
      FUNCTION SIMPUN(X,Y,N)
C     FORTRAN IV FUNCTION FOR SIMPSONS RULE INTEGRATION
C     EQUAL OR UNEQUAL INTERVALS.  W. FRANK.  DTMB, CODE 584, 7-16-65
C
      DIMENSION X(50),Y(50)
    2 FORMAT(23H NON MONOTONE X SIMPUN                 I4,1PE12.4)
      IF(N-2) 7,5,4
    5 S=(Y(1)+Y(2))*(X(2)-X(1))/2.
      GO TO 6
    7 S=0.
      GO TO 6
    4 M=N-1
      S=(X(2)-X(1))/6.*(Y(1)*((X(2)-X(3))/(X(1)-X(3))+2.)+Y(2)*((X(1)-X(
     X3))/(X(2)-X(3))+2.)-Y(3)*(X(2)-X(1))**2/((X(1)-X(3))*(X(2)-X(3))))
      LB=2
      IF(N.EQ.3) GO TO 8
      S=S+(X(3)-X(2))/6.*(Y(2)*((X(3)-X(4))/(X(2)-X(4))+2.)+Y(3)*((X(2)-
     XX(4))/(X(3)-X(4))+2.)-Y(4)*(X(3)-X(2))**2/((X(2)-X(4))*(X(3)-X(4))
     X))
      LB=3
    8 DO 1 K=LB,M
      IF(ABS(X(K+1)-X(1)).GE.ABS(X(K)-X(1))) GO TO 1
    3 WRITE(6,2) K,X(K)
      GO TO 7
    1 S=S+(X(K+1)-X(K))/6.*(Y(K)*((X(K+1)-X(K-1))/(X(K)-X(K-1))+2.)+Y(K+
     X1)*((X(K)-X(K-1))/(X(K+1)-X(K-1))+2.)-Y(K-1)*(X(K+1)-X(K))**2/((X(
     XK)-X(K-1))*(X(K+1)-X(K-1))))
    6 SIMPUN=S
      RETURN
      END
```

```
      SUBROUTINE PLOTPR (N, GPM)
C        INSTRUCTIONS FOR PLOTTING PERCENTAGE EXCEEDANCE DIAGRAMS
      COMMON /BL1/ SHIPN(6), TFT(8), YT(24), YT2(32), TCLR(16), XTIT(3),
     . PCTIT(3), BUFF(1024), XP(325), YP(325), XMIN, XMAX, XINC, XLG,
     . YMIN, YINC, ZMIN, ZINC, ISYM, TWS(3), V, L, CLR, BPL, DISPL, M
      COMMON /BL3/ GP(36), GP2(36), YPE(36,2), ZPE(36)
      CALL PLOT (10.5, 0.0, -3)
      CALL AXIS (0.0, 0.0, PCTIT, 21, 5.0, 90.0, 0.0, 20.0)
    1 YY1 = 8.6
      YY2 = 8.2
      CALL SYMBOL (0.2, YY1, 0.12, SHIPN, 0.0, 60)
      CALL SYMBOL (1.0, YY2, 0.12, 3HL =, 0.0, 3)
      CALL NUMBER (1.4, YY2, 0.12, BPL, 0.0, 1)
      CALL SYMBOL (2.05, YY2, 0.12, 2HFT, 0.0, 2)
      CALL SYMBOL (3.0, YY2, 0.12, 3HV =, 0.0, 3)
      CALL NUMBER (3.4, YY2, 0.12, V, 0.0, 1)
      CALL SYMBOL (3.95, YY2, 0.12, 5HKNOTS, 0.0, 5)
   84 CALL SYMBOL (1.0, 7.4, 0.10, TWS, 0.0, 30)
      IF(N.EQ.1) GO TO 10
      IF(M.EQ.7) GO TO 10
      MM = M * 2 - 1
      CALL SYMBOL (5.0, YY2, 0.12, TCLR(MM), 0.0, 20)
      CALL SYMBOL (7.4, YY2, 0.12, 1H=, 0.0, 1)
      CALL NUMBER (7.6, YY2, 0.12, CLR, 0.0, 1)
      CALL SYMBOL (8.2, YY2, 0.12, 2HFT, 0.0, 2)
   10 IF(N.EQ.2) GO TO 12
      LL=L*3-2
      CYCLE = 1.0 / 3.75
      CALL LBAXS (0.0, 0.0, YT(LL), -30, 7.5, 0.0, GPM, CYCLE)
      NB = 7
      NP = 29
      GO TO 15
   12 MM = M * 4 - 3
      CYCLE = 0.5
      CALL LBAXS (0.0, 0.0, YT2(MM), -40, 6.0, 0.0, GPM, CYCLE)
      NB = 1
      NP = 35
   15 CONTINUE
      XP(NP+1) = GPM
      XP(NP+2) = CYCLE
      YP(NP+1) = 0.0
      YP(NP+2) = 20.0
      DO 18 I=1,NP
      II = NB - 1 + I
      IF(N.EQ.2) GO TO 17
      XP(I)=GP(II)
      GO TO 18
   17 XP(I) = GP2(II)
   18 CONTINUE
      DO 25 I=1,NP
      II = NB - 1 + I
      IF(N.EQ.2) GO TO 22
      YP(I)=YPE(II,1)
      GO TO 25
```

```
22 YP(I) = ZPE(II)
25 CONTINUE
   CALL LGLIN (XP, YP, NP, 1, 0, ISYM, -1)
   IF (N .GT. 1) GO TO 30
   DO 28 I=1,NP
   II = NB-1 + I
28 YP(I) = YPE(II,2)
   CALL LGLIN (XP, YP, NP, 1, 0, ISYM, -1)
30 CONTINUE
   RETURN
   END
```

```
      SUBROUTINE PLOTRS (N, J)
C       INSTRUCTIONS FOR PLOTTING RESPONSE AMPLITUDES VS. SIGN.WAVE HT.
      COMMON /BL1/ SHIPN(6), TFT(8), YT(24), YT2(32), TCLR(16), XTIT(3),
     . PCTIT(3), BUFF(1024), XP(325), YP(325), XMIN, XMAX, XINC, XLG,
     . YMIN, YINC, ZMIN, ZINC, ISYM, TWS(3), V, L, CLR, BPL, DISPL, M
      COMMON /BL2/ SWH(323), RA(323,3), R2(323), NK,
     .               SWHPM(51), RAPM(51,3), R2PM(51)
      DIMENSION ST1(2), ST2(3), ST3(4)
      DATA ST1 / 10HSIGNIFICAN, 10HT VALUES    /
      DATA ST2 / 10HMOST PROBA, 10HBLE EXTREM, 10HE VALUES    /
      DATA ST3 / 10HEXTREME VA, 10HLUES FOR D, 10HESIGN CONS,
     . 10HIDERATION /
      CALL PLOT (10.5, 0.0, -3)
      IF(N.EQ.2) GO TO 12
      IF(YINC.GT.0.) YPMAX=10.*YINC
      GO TO 14
   12 IF (ZINC .GT. 0.0) YPMAX = 10.0 * ZINC
   14 NP = 0
      DO 35 K=1,NK
      IF (SWH(K) .GT. XMAX) GO TO 35
      IF(N.EQ.2) GO TO 22
      IF(RA(K,J).GT.YPMAX .AND. YINC.GT.0.) GO TO 35
      GO TO 24
   22 IF (R2(K) .GT. YPMAX .AND. ZINC .GT. 0.0) GO TO 35
   24 NP = NP + 1
      XP(NP) = SWH(K)
      IF(N.EQ.2) GO TO 32
      YP(NP)=RA(K,J)
      GO TO 35
   32 YP(NP) = R2(K)
   35 CONTINUE
      NP1 = NP + 1
      NP2 = NP + 2
      XP(NP1) = XMIN
      XP(NP2) = XINC
      IF(N.EQ.2) GO TO 42
      IF(YINC.LE.0.) GO TO 44
      YP(NP1) = YMIN
      YP(NP2) = YINC
      GO TO 45
   42 IF (ZINC .LE. 0.0) GO TO 44
      YP(NP1) = ZMIN
      YP(NP2) = ZINC
      GO TO 45
   44 CALL SCALE (YP, 8.0, NP, 1)
   45 CALL AXIS (0.0, 0.0, XTIT, -30, XLG, 0.0, XMIN, XINC)
      IF(N.EQ.2) GO TO 52
      LL=L*3-2
      CALL AXIS (0.0, 0.0, YT(LL),30, 8.0, 90.0, YP(NP1), YP(NP2))
      GO TO 54
   52 MM = M * 4 - 3
      CALL AXIS (0.0, 0.0, YT2(MM), 40, 8.0, 90.0, YP(NP1), YP(NP2))
   54 CALL SYMBOL (0.5, 9.2, 0.12, SHIPN, 0.0, 60)
```

```
      CALL SYMBOL (1.0, 8.6, 0.12, 3HL =, 0.0, 3)
      CALL NUMBER (1.4, 8.6, 0.12, BPL, 0.0, 1)
      CALL SYMBOL (2.05, 8.6, 0.12, 2HFT, 0.0, 2)
      CALL SYMBOL (3.0, 8.6, 0.12, 3HV =, 0.0, 3)
      CALL NUMBER (3.4, 8.6, 0.12, V, 0.0, 1)
      CALL SYMBOL (3.95, 8.6, 0.12, 5HKNOTS, 0.0, 5)
      CALL SYMBOL (1.0, 7.6, 0.10, TWS, 0.0, 30)
      IF(N.EQ.2) GO TO 58
      GO TO (91,92,93),J
   91 CALL SYMBOL (1.0, 8.0, 0.10, ST1, 0.0, 20)
      GO TO 94
   92 CALL SYMBOL (1.0, 8.0, 0.10, ST2, 0.0, 30)
      GO TO 94
   93 CALL SYMBOL (1.0, 8.0, 0.10, ST3, 0.0, 40)
   94 GO TO 60
   58 IF (M .EQ. 7) GO TO 60
      MM = M * 2 - 1
      CALL SYMBOL (5.0, 8.6, 0.12, TCLR(MM), 0.0, 20)
      CALL SYMBOL (7.4, 8.6, 0.12, 1H=, 0.0, 1)
      CALL NUMBER (7.6, 8.6, 0.12, CLR, 0.0, 1)
      CALL SYMBOL (8.2, 8.6, 0.12, 2HFT, 0.0, 2)
   60 CALL LINE (XP, YP, NP, 1, -1, ISYM)
      YPMAX = 10.0 * YP(NP2)
      NP = 0
      DO 75 K=1,46
       IF (SWHPM(K) .GT. XMAX) GO TO 75
      IF(N.EQ.2) GO TO 62
      IF(RAPM(K,J).GT.YPMAX) GO TO 75
      GO TO 64
   62 IF (R2PM(K) .GT. YPMAX) GO TO 75
   64 NP = NP + 1
      XP(NP) = SWHPM(K)
      IF(N.EQ.2) GO TO 72
      YP(NP)=RAPM(K,J)
      GO TO 75
   72 YP(NP) = R2PM(K)
   75 CONTINUE
      XP(NP+1) = XP(NP1)
      XP(NP+2) = XP(NP2)
      YP(NP+1) = YP(NP1)
      YP(NP+2) = YP(NP2)
      CALL LINE (XP, YP, NP, 1, 0, 3)
      RETURN
      END
```

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